EPA/ROD/R10-00/035
2000

EPA Superfund
Record of Decision:

KETCHIKAN PULP COMPANY
EPA ID: AKD009252230
OU 02
KETCHIKAN, AK
03/29/2000

Ketchikan Pulp Company
Marine Operable Unit
Ketchikan, Alaska

Record of Decision

March 29, 2000

TABLE OF CONTENTS

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
AET	apparent effects threshold
AOC	area of concern
ARAR	applicable or relevant and appropriate requirement
AVS	acid-volatile sulfide
BOD	biochemical oxygen demand
BSAF	biota-sediment accumulation factor
CAD	confined aquatic disposal
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CoC	chemicals of concern
COD	chemical oxygen demand
CoPC	chemical of potential concern
cy	cubic yard
DTSR	detailed technical studies report
EPA	U. S. Environmental Protection Agency
Gateway	Gateway Forest Products Company, Inc.
ICP	institutional control plan
KPC	Ketchikan Pulp Company
LTF	log transfer facility
MCUL	minimum cleanup level
mgd	million gallons per day
MLLW	mean lower low water
NCDF	Nearshore confined disposal facility
NCP	National Contingency Plan
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	operation and maintenance
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCDD/F	polychlorinated dobbins-p-dioxin and polychlorinated dibenzofuran
PRP	potentially responsible party
RAO	remedial action objective
RfD	reference dose
RI/FS	remedial investigation and feasibility study
ROD	Record of Decision
SQS	sediment quality standard
SOD	sediment oxygen demand
TBC	to be considered
TCDD	tetrachlorodibenzo-p-dioxin
TDG	Technical Discussion Group
TEC	toxic equivalent concentration
TOC	total organic carbon
TRV	toxicity reference value
USFWS	U. S. Fish and Wildlife Service
WCSQV	site-specific sediment quality values for Ward Cove
WCSQV(1)	Ward Cove sediment quality value analogous to the SQS
WCSQV(2)	Ward Cove sediment quality value analogous to the MCUL

PART 1: THE DECLARATION

Site Name and Location

The Ketchikan Pulp Company (KPC) site is located on the shoreline of Ward Cove, near Ketchikan, Alaska. The U. S. Environmental Protection Agency (EPA) identification number for the KPC site is AKD009252230. The KPC site is not listed on the National Priorities List (NPL).

The site was divided into two administrative units for investigation purposes: the Uplands Operable Unit and the Marine Operable Unit. This Record of Decision (ROD) addresses only the Marine Operable Unit. A separate ROD addresses the Uplands Operable Unit.

The KPC facility began operations as a dissolving sulfite pulp mill in 1954 and discharged pulp mill effluent to Ward Cove until March 1997, when pulping operations terminated. Equipment associated with pulp mill operations has largely been dismantled and removed from the site. In November 1999, the KPC upland mill property and patented tidelands in Ward Cove were sold to Gateway Forest Products Company, Inc. (Gateway). Gateway will be using the site to operate a sawmill and a veneer mill, producing lumber and veneer, chips for pulp, and hog fuel as a by-product.

Statement of Basis and Purpose

This decision document presents the Selected Remedy for the Marine Operable Unit of the KPC site, which was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended, and to the extent practicable, the National Contingency Plan (NCP). This decision is based on the Administrative Record file for this site.

The State of Alaska Department of Environmental Conservation (ADEC) concurs with the Selected Remedy.

Assessment of Site

The response action selected in this ROD is necessary to protect the environment from actual or threatened releases of hazardous substances into the environment. Such a release may present an imminent and substantial endangerment to the environment.

Description of Selected Remedy

The Marine Operable Unit consists of approximately 250 acres in Ward Cove, of which approximately 80 acres have been designated as an Area of Concern (AOC) where remedial action may be warranted because sediments impacted by historical releases from the KPC site pose a risk to benthic organisms. This POD describes the Selected Remedy for sediment remediation of this 80-acre AOC.

In order to eliminate or minimize the ecological risk associated with the toxicity of Ward Cove sediments to benthic organisms, the response action is intended to:

- Reduce toxicity of surface sediments

- Enhance recolonization of surface sediments to support a healthy marine benthic infauna community with multiple taxonomic groups.

A benefit of achieving these remedial action objectives (RAOs) is that a healthy benthic infaunal community serves as a diverse food source to larger invertebrates and fishes.

The Selected Remedy consists of the following interrelated components (see Figure 19a and 19b):

- Placement of a thin-layer cap (approximately 6-to 12-inches) of clean, sandy material where practicable. Thin-layer capping is estimated to be practicable over approximately 21-acres within the AOC. Thin-layer capping is preferable over mounding.

- Placement of clean sediment mounds in areas where thin-layer capping is either infeasible or impracticable, and where mounding is considered to be practicable. Mounding is currently considered to be practicable in areas where the organic- rich sediments are less than 5 ft thick and have a bearing capacity that is greater than 6 psf. Mounding is estimated to be practicable over approximately 6- acres within the AOC.

- Dredging of approximately 17,050 cubic yards (cy) of bottom sediments from an approximate 4-acre area in front of the main dock and dredging of approximately 3,500 cy of bottom sediments from an approximate 1-acre area near the shallow draft barge berth area to accommodate navigational depths, with disposal of the dredged sediments at an upland location. After dredging, a thin-layer cap of clean, sandy material will be placed in dredged areas unless native sediments or bedrock is reached during dredging.

- Removal of sunken logs from the bottom of Ward Cove in areas to be dredged.

- Natural recovery in areas where neither capping nor mounding is practicable. Natural recovery is estimated to be the remedy for approximately 50 acres of the 80-acre AOC, as follows:

  1) an 8-acre area in the center of Ward Cove and a 2-acre area near Boring Station 8 that exhibit a very high-density of sunken logs (>500 logs/10,000 m2);

  2) a 13.5-acre area where water depth to the bottom of the Cove is greater than -120 ft mean lower low water (MLLW) and the depth of the sediment is currently considered to be too great to cap;

  3) a 14.5-acre area where slopes are estimated to be greater than 40 percent and are currently considered to be too steep for capping or mounding material to remain in place;

  4) an 11-acre area where the organic-rich sediments do not have the bearing capacity (i.e., strength is less than 6 psf) to support a sediment cap and are too thick (i. e., thickness is greater than 5 ft) to practicably allow for placement of sediment mounds; and,

  5) a 0.2-acre area near the sawmill log lift where maintenance dredging generally occurs on an annual basis.

Institutional controls requiring that post-remediation activities within the AOC that materially damage the thin-layer cap or mounds will be required to redress such damage, at the direction of EPA.

Implementation of a long-term monitoring program for the remedial action until RAOs are achieved, at the direction of EPA.

Subtidal investigation of sediments near the east end of the main dock, and subsequent dredging and disposal of PAH-contaminated sediments, as deemed appropriate by EPA.

Statutory Determinations

The Selected Remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable. The remedy in this operable unit does not satisfy the statutory preference for treatment as a principal element of the remedy for the following reasons. Treatment was evaluated for sediment remediation but was not considered further because: 1) available in situ treatment technologies would be difficult to implement and may not be effective on the scale required for sediments in Ward Cove; 2) costs for in situ remediation would be high and there would likely be little or no improvement in ecological conditions within Ward Cove; and 3) dredging of problem sediments followed by separation of fine wood debris from the dredged sediments would be difficult to implement (requiring significant material handling), would generate large amounts of wastewater that would require treatment, and would be extremely costly while producing little or no environmental benefit. No source materials constituting principal threats, as defined in EPA guidance, will be addressed within the scope of this remedial action. Because this remedy will result in substances remaining on-site above levels that may adversely affect benthic, organisms, a review will be conducted within 5 years after initiation of remedial action to ensure that the remedy continues to provide adequate protection of the environment.

Data Certification Checklist

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for this site.

- Chemicals of concern (CoCs) and their respective concentrations (see Table 1).

  – Chemicals of Potential Concern. (CoPCs) and their respective concentrations in sediments (see Tables 2, 3, and 4).

- Baseline risk represented by the CoCs.

  – Human health risk represented by the CoPCs (see Table 5 and Section 7.1, Human Health Risks). No CoCs were identified for baseline human health risk.

  – Assessment of baseline ecological risks associated with sediment toxicity (see Tables 6 and 7 and Section 7.2, Ecological Risks - Sediment Toxicity). CoCs are ammonia, sulfide, and 4-methylphenol.

  – Assessment of baseline ecological risks associated with bioaccumulation in representative birds and mammals at the top of the Ward Cove food web (see Table 8 and Section 7.3, Ecological Risks-Food-Web Assessment). No CoCs were identified for the food-web evaluation.

- Cleanup levels established for CoCs and the basis for these levels.

  – Chemical-specific bulk sediment chemistry values are not being established as cleanup levels for the CoCs at this site. Rather, it is believed that the success of the remedy will be best measured by biological indicators that are most directly representative of the RAOs, i.e., sediment toxicity and benthic community structure. Site-specific biological criteria for sediment toxicity and benthic community analyses will be established in a Monitoring and Reporting Plan to evaluate the protectiveness of the Remedial Action and whether the RAOs are being achieved (see Sections 7.4 and 8).

- No source materials constitute a principal threat.

- Current and reasonably anticipated future use assumptions used in the baseline risk assessment and ROD (see Sections 6, 7, and 9). Current and potential future beneficial uses of land and groundwater are not relevant to this ROD, which addresses marine sediments.

- Potential land and groundwater use that will be available at the site as a result of the Selected Remedy is not relevant to this ROD, which addresses marine sediments.

- Estimated capital, annual operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected (see Section 11.3, Summary of the Selected Remedy Costs).

- Key factors that led to selecting the remedy (see Section 10, Comparative Analysis of Alternatives).

Authorizing Signature

PART 2: THE DECISION SUMMARY

1. SITE NAME, LOCATION, AND BRIEF DESCRIPTION

The former KPC mill is located on the northern shoreline of Ward Cove, approximately 5 miles (8 km) north of Ketchikan, Alaska (Figure 1). KPC operated the pulp mill from 1953 until its shutdown in March 1997. The KPC site is comprised of uplands and patented tidelands in Ward Cove.

In addition to receiving effluent discharges from the KPC pulp mill, Ward Cove was also used by KPC for log handling operations: towing and storing log rafts; transferring sawn wood products, chips, and hog fuel to barges; and loading logs onto barges. The other principal discharger to Ward Cove is the Wards Cove Packing Company fish cannery (the cannery) located on the south shore of the Cove.

In November 1999, the KPC upland mill property and patented tidelands in Ward Cove were sold to Gateway Forest Products, Inc. (Gateway). Gateway will be using the site to operate a sawmill and a veneer mill, producing lumber and veneer, chips for pulp, and hog fuel as a by-product.

EPA has divided the KPC site into two administrative units: an Uplands Operable Unit (Uplands OU) and a Marine Operable Unit (Marine OU). The Uplands OU encompasses areas that may have been affected by pulp mill operations, including the site of former pulp mill operations, a wood and ash disposal landfill, and a pipeline road. The Marine OU encompasses all of Ward Cove and other marine areas where there has been a migration of hazardous substances from Ward Cove or the Uplands OU.

This ROD is for the Marine Operable Unit. Mill operations affected sediment in Ward Cove through the release of large quantities of organic material as by-products from wood pulping. This organic material has altered the physical structure of the sediments, and thus the type and amount of benthic (bottom-dwelling) organisms. Degradation of the organic-rich pulping by-product has led to anaerobic conditions in the sediment and production of ammonia, sulfide, and 4-methylphenol in quantities that are potentially toxic to benthic organisms in the sediments on the bottom of Ward Cove.

Threatened and endangered species potentially occurring within the local area include the American peregrine falcon, which is listed by the U. S. Fish and Wildlife Service (USFWS) as an endangered species, the humpback whale, which is listed by the National Marine Fisheries Service (NMFS) as a threatened species, and the Stellar sea lion, which is listed by NMFS as a threatened species.

EPA is the lead agency for the Marine OU. The EPA identification number for the KPC site is AKD009252230. The KPC site is not listed on the NPL. The source of funding for this remediation is Potentially Responsible Party (PRP) enforcement.

2. SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.1 Site History

The KPC mill operated continuously from 1954 until 1997, processing raw logs into lumber, pulp, and hog fuel. The principal product of the KPC mill was dissolving-grade sulfite pulp.

When the pulp mill was operating, logs were brought to the mill, de-barked, and cut into wood chips. The chips were mixed with cooking acid (magnesium bisulfite) to remove lignin, pitch, and carbohydrate degradation products. The chips were then placed into one of nine “digesters” where they were cooked at high temperature and pressure to separate pulp from other constituents of the wood. Spent cooking acid (“red liquor”) was then removed. The pulp was washed and bleached with chlorine caustic. The pulp was then dried, formed into sheets, cut and rolled. The finished pulp was used to manufacture products such as fabrics, rayon, cellophane, explosives, lacquers, moldable products, pharmaceuticals, food additives, sponges, emulsifiers for food and paint, artificial leathers, laminates, tissues, and specialty papers. The specialized pulp product requires that 60-65 percent of the incoming wood material be extracted in the pulping process. Spruce and hemlock were the primary wood species used at the facility.

When pulp production began in 1954, effluent from the mill was discharged directly to Ward Cove. After 1971, when federal and state regulations went into effect, effluent was treated in a wastewater treatment plant located at the mill. After treatment, wastewater was discharged to Ward Cove. Over time, a number of improvements were made to waste management and effluent treatment procedures at the mill. These improvements resulted in a substantial reduction in the release of spent sulfite liquor, suspended and settleable solids, and oxygen- consuming substances (biochemical oxygen demand [BOD]), Temporal changes in permit limits and improvements in effluent quality are summarized in Figure 2.

2.2 Actions to Date

No removals or early actions were completed in the Marine Operable Unit of the KPC site. To date, no sediment remediation projects have occurred in Ward Cove.

2.3 Investigative History

Ward Cove is a deep estuary, approximately 1 mile long with a maximum width of 0.5 mile. The shoreline of the cove is mostly rocky (basalt) and relatively steep. Over two-thirds of the cove is deeper than 100 feet. Sediments in the cove are subtidal (i.e., below the tide line); intertidal sediments are limited to a very small area near the mouth of Ward Creek.

Numerous environmental studies of Ward Cove have been conducted to evaluate the potential environmental effects associated with historical discharges from the KPC facility (Table 9). Historical studies focused on water quality assessments and sediment chemistry and toxicity studies. These studies documented a variety of potentially adverse conditions and effects in the water column and sediments of Ward Cove, Spatial variations in sediment characteristics were generally clear, with elevated levels of CoPCs and sediment toxicity found nearest the mill and cannery.

Pursuant to a 1995 consent decree (see Section 2.4 below) and in support of the remedial investigation and feasibility study (RI/FS), comprehensive studies of the Ward Cove area were conducted by KPC, with EPA oversight, in 1996 and 1997 to evaluate the extent to which sediments in Ward Cove may pose risks to humans and the environment and therefore potentially warrant remediation. Human health evaluations focused on potential risks associated with contacting sediment or eating seafood from the study area. Ecological evaluations focused on the effects of sediment contaminants on animals. These evaluations consisted of sediment chemical analyses, sediment toxicity testing, and food-web assessments. Sediment toxicity testing was performed in a laboratory by exposing marine animals to sediment from the study area. Food-web assessments were performed by estimating potential risks posed by chemicals in sediment to representative birds and mammals that live at the top of the food web in Ward Cove. Details for these studies are provided in subsequent sections.

In 1997, an expanded site investigation (E&E 1998) was performed at the KPC site to provide EPA with adequate information to determine whether the site is eligible for placement on the NPL based on the Hazard Ranking System. This work was separate from the RI/ FS. The expanded site investigation data were considered in this ROD; however, these data were not used to delineate remediation areas because of problems associated with the accuracy of the station locations (U.S. EPA 1998).

Extensive investigations were also completed at the Uplands Operable Unit. As part of those investigations, the potential for releases of contaminants from the uplands site to

Ward Cove sediments was investigated. Soil removal actions have been completed at the site. Based on the findings of environmental investigations for both the Marine and Uplands OUs, EPA concludes there are no further physical actions necessary to control contaminant releases from the uplands site to the Cove. Additionally, the Institutional Controls Plan for the Uplands OU will provide a framework for ensuring that decisions regarding the Upland OU remain protective of human health and the environment.

2.4 Enforcement History

The KPC site is not listed on the NPL. The sediment investigation and feasibility study for the Marine Operable Unit is being implemented pursuant to a Clean Water Act and Clean Air Act consent decree, but it is EPA's intent to implement the actual remediation under EPA Superfund remedial authorities. Additional details are provided below.

The remediation of Ward Cove was originally part of a consent decree with KPC dated September 19, 1995. The consent decree embodied a settlement between the United States and KPC for violations at the KPC facility of the Clean Water Act and the Clean Air Act. Under the terms of the settlement, KPC agreed to pay a penalty of $3.1 million. KPC also agreed to implement requirements for operating the mill (e.g., using only certified wastewater treatment operators) and to perform certain projects.

One such project was to develop and implement the Ward Cove Sediment Remediation Project. As described in the consent decree, the focus of this project was on evaluating and remediating sediments, Work plans and schedules for the sediment remediation project are set forth in the consent decree. The RI/FS work has proceeded in accordance with the consent decree. EPA Superfund has provided oversight of the RI/FS and work performed under the consent decree; work completed to date is deemed to be consistent with the NCP. EPA intends, however, to complete the sediment remediation project under the authority of CERCLA. EPA intends to negotiate a CERCLA Remedial Design/Remedial Action consent decree with KPC, its parent company, Louisiana- Pacific Corporation, and the new owner of the Ward Cove facility, Gateway.

In 1997, an administrative order on consent (consent order) was negotiated between EPA, ADEC, KPC, and Louisiana-Pacific Corporation (the parent company of KPC) to address response actions for the Uplands Operable Unit at the KPC site. The consent order allowed for EPA's recovery of oversight costs for both the Uplands and Marine Operable Units.

To date, no sediment remediation activities have occurred in Ward Cove. However, minor maintenance dredging projects have occurred near the KPC site pursuant to U. S. Army Corps of Engineers dredging permits.

3. COMMUNITY PARTICIPATION

There has been extensive public involvement at the KPC site because of the high degree of community interest. In February 1997, a questionnaire was sent to every mailing address in Ketchikan asking individuals to identify concerns regarding the potential contaminant releases associated with the facility and the ongoing environmental investigation and remediation activities. ADEC personnel also conducted a limited number of door- to- door interviews to learn more about community concerns. Information gathered in this process was used by EPA, ADEC, and KPC to prepare a Community Involvement Plan and to help identify areas that should be studied. Also, a technical discussion group (TDG) of concerned citizens was formed. KPC provided funding that the group used to hire independent consultants to assist in reviewing and understanding the complex technical documents.

At each significant stage of the investigation, EPA and KPC held public meetings. Most of these meetings were preceded by an afternoon availability session where members of the community could meet one-on-one with EPA and KPC project staff and consultants. In total, 13 public meeting and public availability sessions were held to discuss the Uplands and

Ward Cove investigations. All public comments were considered in the development of the investigation.

In addition, EPA and ADEC hosted an Education Workshop for interested community members, to promote a better understanding of risk assessment. The workshop covered both the assessment process and technical concepts related to assessing risks to human health and the environment. In response to community concerns and questions about water quality issues in Ward Cove, EPA and ADEC hosted a lunchtime event to discuss Ward Cove water quality issues, including the impaired water body status of the Cove and implications for future permitting.

A mailing list (approximately 240 addressees), was created to keep interested citizens informed of activities and significant issues, EPA and ADEC created flyers and newspaper advertisements announcing the release of significant documents, meetings, and availability sessions. Several newsletters providing more in-depth information were sent out.

Copies of all project documents were made available to the public at four different information repositories: the Ketchikan Public Library (629 Dock Street), the Ketchikan Office of ADEC (540 Water Street), the Juneau Office of ADEC (410 Willoughby Avenue), and the EPA Region 10 Records Center on the 7th floor of 1209 Sixth Avenue in Seattle, Washington. Complete Administrative Records are available at the Ketchikan Public Library, the Juneau Office of ADEC, and the EPA Region 10 Records Center.

For the Marine Operable Unit, the draft RI/FS (referred to as the Detailed Technical Studies Report or the DTSR [Exponent 1999]) was made available for public review and comment from August 3 through October 1, 1998. A notice of availability of this report was published in the *Ketchikan Daily News* on August 1, 1998, and in *The Local Paper* on August 5, 1998. An availability session, a public meeting, and a meeting with the TDG were held on September 17, 1998, to discuss this report, and notice of the meeting was published in both the *Ketchikan Daily News* and *The Local Paper*, EPA received 13 comment letters during the public comment period. Comments from ADEC were received on January 19, 1999. EPA provided a summary of public comments and responses to those comments on April 26, 1999. All comments received during the public comment period were considered when revising the RI/ FS.

The Proposed Plan for the Marine Operable Unit of the KPC site (U. S. EPA 1999b) was released on July 12, 1999, A notice of availability of this plan and the Administrative Record was published in the *Ketchikan Daily News* on June 30 and July 14, 1999, and in *The Local Paper* on June 30 and July 14, 1999. On July 21, 1999, notices of extension of the 30-day public comment period to 60 days were placed in both papers. A public availability session, which provided a forum for informal discussion on the Proposed Plan, and a public meeting were held in Ketchikan on July 29, 1999. The public comment period closed on September 9, 1999. EPA received 12 written comment letters. In addition, EPA received two written comments and recorded verbal comments from four individuals at the public meeting on the Proposed Plan. EPA’s response to comments received during the public comment period is included in the Responsiveness Summary, which is included as Part 3 of this ROD. The decision in this ROD is based on the administrative record for this site.

4. SCOPE AND ROLE OF RESPONSE ACTION

The KPC site is divided into two administrative units: the Marine Operable Unit and the Uplands Operable Unit. The boundary between the two operable units is the mean higher high tide level. The response action described in this ROD addresses only the Marine Operable Unit. The Uplands Operable Unit is addressed in a separate ROD. Response actions in the Uplands and Marine Operable Units will be conducted independently.

The Uplands Operable Unit consists of approximately 85 acres and encompasses the pulp mill area, the wood waste and ash disposal landfill, the dredge spoil subarea, the former storage area along the water pipeline access road, and other land- based areas that may have been affected by mill operations. Concentrations of arsenic, lead, dioxins, benzo[a] pyrene, and polychlorinated biphenyls in the Uplands Operable Unit exceed screening concentrations and were identified as CoPCs to be evaluated in the risk assessment. The response action for the Uplands Operable Unit consists of a combination of removal and off- site disposal of soils, closure of the wood waste and ash disposal landfill, and institutional controls.

The Marine Operable Unit consists of approximately 250 acres in Ward Cove, of which approximately 80 acres have been designated as an AOC where remedial action may be warranted because sediment contamination poses a risk to benthic organisms. Sediments in the AOC are believed to be toxic to benthic biota as a result of in situ biodegradation of organic material released by mill operations. No current or potential unacceptable risks to humans are associated with sediment conditions in the Marine OU. The response action for the Marine OU is intended to reestablish a healthy benthic community in Ward Cove. Several different types of remedial actions will be used to address the spatial variability in sediment toxicity and bottom topography, including dredging and upland disposal of problem sediments, thin capping and mounding of clean sediment on the bottom, and natural recovery.

5. SITE CHARACTERISTICS

The Marine Operable Unit consists of approximately 250 acres in Ward Cove, of which approximately 80 acres have been designated as an AOC where remedial action may be warranted because sediment contamination poses a risk to benthic organisms. The general features of Ward Cove, potential sources of contamination, and the results of site investigations are summarized in the following sections.

5.1 Overview

Ward Cove is located on the north side of Tongass Narrows and is approximately 1 mile (1.6 km) long with a maximum width of 0.5 mile (0.8 km) (Figure 3). The orientation of the Cove is southwest to northeast. The Cove is bounded by Slide Ridge to the north and Ward Mountain to the south. Surrounding terrain is mountainous and forested. The shoreline of the Cove is mostly rocky and relatively steep. Water depths range from - 10 ft below MLLW at the head of the Cove to - 200 ft below MLLW at the mouth. Ward Creek is the major source of freshwater inflow; the creek enters at the head of the Cove. The discharge from Ward Creek varies widely and responds quickly to the large amounts of rainfall that occur in the region. The average flow velocity in the lower portion of Ward Creek is approximately 8.3 cm/s.

Vertical water circulation in Ward Cove is typical of fjord-like estuaries: net inflow occurs in deep water (below about 50 ft) and net outflow occurs in surface water. This pattern is clearest in the central and inner parts of the Cove; eddies from the rapid currents in Tongass Narrows may be responsible for obscuring this flow pattern in the outer part of the Cove. Lateral water circulation is predominantly counterclockwise, with outflow occurring principally along the northern shoreline.

The former KPC mill is located on the north shore of the inner part of the Cove and covers approximately 70 acres. Nearby areas are used for industrial/commercial, residential, and recreational purposes. The other major industrial operation on the Cove itself is the Wards Cove Packing Company fish cannery, which is located on the south side of the outer part of the Cove.

5.2 Sources of Contamination

A variety of processes and conditions in the Cove and the associated upland area were considered as possible sources of CoPCs to Ward Cove. CoPCs are those chemicals that were identified as a potential threat to human health or the environment and were evaluated further in the baseline risk assessments. The processes and conditions considered possible sources of CoPCs included the following:

- Historical KPC wastewater discharges from the dissolving sulfite pulp mill
- Log handling practices (in-water log rafting)
- Wood waste and ash disposal landfill
- Nearshore fill subarea (including surface water runoff and groundwater discharge)
- Wood waste and sludge disposal subarea (including surface water runoff and groundwater discharge)
- Groundwater seeps
- Dredge spoil subarea
- Storm water discharges
- Release of airborne contaminants from the power boilers
- Spills and accidental releases.

Releases from the fish cannery are an additional potential source of CoPCs to Ward Cove. All of these sources except storm water discharges, aerial deposition, and spills are shown in Figure 4. CoPCs were also selected on the basis of historical environmental studies that documented chemical concentrations in sediments and in seafood tissue.

Historical wastewater discharges from the former KPC pulp mill are considered to be the predominant source of chemicals and organic matter to Ward Cove sediments. From 1954 to 1971, KPC wastewater was discharged at the shoreline of Ward Cove through outfalls 001, 002, 003, and 004. These discharges included both process and sanitary wastewater. Process water contained wood fibers and other organic material produced during the pulping process. Historical discharge rates were 38–45 million gallons per day (mgd). Primary treatment was instituted in 1971, and outfall 003 was eliminated. Outfall 002 was eliminated in 1972, and its discharge routed to outfall 001 (outfalls were also renumbered in 1972). Secondary treatment was installed in 1980, and effluent neutralization of all process water discharges was installed in 1993. Discharge of all pulping waste ceased in March 1997; however, approximately 2 mgd of water continues to be discharged through outfall 001 to preserve a pipeline constructed of wood staves.

In the wood pulping process, the cellulose component of wood is isolated and extracted as pulp, and the finished pulp is used to manufacture products. In the process, other wood components (e.g., lignin, pitch, partially-degraded organic constituents) become by-products that are present in the effluent process water discharged from the mill. Historical releases from the KPC pulp mill, in the form of pulping or red liquor, would have contained undegraded or partially degraded organic by-products of wood (which would settle out to the sediments) and dissolved constituents of wood (which would be dispersed in the water column). Where present, the large amounts of partially degraded organic matter that settled on the bottom now constitute the “sediment” that is available for habitat for benthic communities, and also the surface sediment that is sampled during environmental investigations. This accumulation of organic matter has created a condition whether the natural degradation products of wood (e.g., sulfide, ammonia) are present at elevated concentrations, and where the bottom is inhospitable to some benthic organisms. Microbial degradation of the organic matter (e.g., wood by-products) leads to oxygen depletion and production of ammonia, sulfide, and other compounds in the sediments.

Sediments affected by releases from the former KPC mill are distinctly different from underlying native sediment and from sediments in many marine and estuarine environments. Affected sediments are generally black and soft (i.e., they have limited strength) with a strong sulfide odor, high in organic and water content, and contain varying amounts of silts, clays, and sand. Sediments may also contain varying amounts of wood chips and bark.

Based on sediment cores collected in Ward Cove, bottom sediments impacted by historical releases from KPC can be divided into two primary classifications: a surface horizon of non-native organic-rich material (as described above) and a subsurface horizon of native silts and clays that are low in organic content and may contain imbedded roots, shells, and schist fragments. The upper organic-rich material ranges in thickness from undetected to greater than 15 ft. Field observations made of grab samples of sediment from areas outside Ward Cove (e.g., near Dawson Point and around East Island) reported surface sediments that were generally brown (not black) in color, and the sediments did not contain wood fiber, wood chips, or bark.

It is believed that the organic-rich non-native bottom sediments that are associated adverse environmental effects are primarily the result of pulping effluent discharges from the former KPC mill. Benthic macroinvertebrate communities sampled in sediments near the former KPC facility were less abundant and less diverse than communities in a nearby non-impacted area. The type of community present in sediments near the facility was considered characteristic of areas affected by high levels of organic enrichment (e.g., the community was dominated by worms, primarily opportunistic species). Historical environmental studies of surface sediments in the Cove reported that concentrations of measured constituents and sediment toxicity generally decreased with increasing distance from the mill. These studies also showed that the sediments contain high concentrations of total organic carbon (TOC), sulfides, BOD, and chemical oxygen demand (COD), which are not conducive for healthy benthic communities.

Logs were rafted in three areas of Ward Cove before being processed by the mill (Figure 4). Log rafting contributed woody debris and whole logs to the bottom of Ward Cove. A very high concentration of sunken logs is present in the center of the inner part of Ward Cove, around the former log rafting area (see Figure 3). Acute and chronic toxic effects to organisms in sediments associated with sunken logs have not been documented and are not suspected (U. S. EPA 1999b). It is recognized, however, that sunken logs may alter native substrate at the bottom of Ward Cove due to the physical presence of whole logs. The presence of some logs on the sea floor would offer a hard substrate habitat in an otherwise soft substrate area, which allows for colonization by different types of organisms (e.g., anemones, starfish, crab). The presence of numerous logs on the sea floor would alter the native substrate, reducing the soft bottom habitat that generally supports sea life that are a food source to larger invertebrates and fishes. In Ward Cove, the presence of sunken logs ranges from some logs to numerous logs. It is also recognized that in some locations, woody debris (e.g., bark) may co-occur with sunken logs, which would likely affect any environmental determinations with respect to observed benthic community impacts and substrate alterations in those areas. Finally, it is unlikely that the sunken logs are a source of ongoing releases of leachates to the water column because of the long period of time (e.g., 30 years) that the logs have been present in the water.

A conceptual site model for Ward Cove sediments is presented in Figure 5. The model identifies potential human and ecological receptors in the Cove and the major pathways by which they may be exposed to CoPCs from sediments. Potential routes of human exposure are direct contact with affected sediments through ingestion or dermal contact, and consumption of seafood that have bioaccumulated chemicals from sediments. Recreational anglers are the most likely human receptors in Ward Cove. Alaska State regulations designate Ward Cove as a nonsubsistence area. Ward Cove is not designated for Customary and Traditional Use.

The major groups of ecological receptors in Ward Cove include plankton, benthic invertebrates, fishes, birds, and marine mammals. These receptors may be exposed to CoPCs from Cove sediments by interactions with the sediments, water, or biota from the Cove. Most CoPCs identified for Ward Cove have strong particle affinities and would be expected to associate with particles and settle to the bottom of the Cove. Therefore, the most likely exposure routes are through contact with sediments or by consumption of organisms that are part of the food web that originates with sediments. Therefore, it is unlikely that plankton, filter-feeding intertidal invertebrates, or planktivorous fishes are at substantial risk of exposure to CoPCs from Ward Cove sediments.

Chemicals in sediments can be transferred to benthic invertebrates by direct contact with sediments, by consumption of organic matter in sediments, or by consumption of other benthic invertebrates. Chemicals can be transferred to benthivorous fishes by direct contact with sediments or by consumption of benthic invertebrates. Chemicals can be transferred to piscivorous fishes, birds, and marine mammals primarily by consumption of fishes that are part of the food web that originates with sediments.

5.3 Sampling Strategy

A sediment investigation was conducted in two phases, in 1996 and 1997, to characterize the distribution of CoPCs and sediment toxicity in Ward Cove. Surface and subsurface sediment was collected for analysis of CoPC concentrations, physical properties, and sediment toxicity. Surface sediment was collected at 44 different locations in Ward, Cove (Figure 6) and 2 locations in Moser Bay (a reference area) (Figure 7). Twenty-eight stations were sampled in Ward Cove during 1996 and 33 were sampled in 1997. Seventeen of the samples collected in 1997 were taken at stations sampled in 1996. Two intertidal surface sediment samples were also collected in 1997, Two surface samples were collected at Moser Bay in both 1996 and 1997. Sediment cores were collected at 16 locations in Ward Cove in 1997 to characterize the vertical extent of CoPCs (Figure 8). Cores were characterized by visual observation as well as analysis of CoPCs and physical properties. In addition, in 1997, selected composite sediment samples were analyzed for polychlorinated dobbins-p-dioxins and polychlorinated dibenzofurans (PCDDs/Fs) (Figure 9) and for engineering properties that affect remediation options.

As part of site investigations, CoPCs were identified. These CoPCs then underwent further study to assess whether any of them are actually CoCs.

In Ward Cove surface sediments, there were three categories of CoPCs:

- CoPCs for human health risks associated with food-web bioaccumulation

- CoPCs for ecological risks associated with sediment toxicity

- CoPCs for ecological risks associated with food-web bioaccumulation.

Bioaccumulative chemicals are those that can build up in tissues of organisms and can be passed to other organisms through the food chain. At this site, the ecological risks associated with sediment toxicity were based on evaluating potential toxic risks to the benthic community (as determined by direct sediment measurements and not by simply documenting alterations in bottom substrate or habitat due to woody material or debris).

The following CoPCs were initially identified:

- **Substances Associated with Organic Matter and Organic Matter Degradation** — TOC, ammonia, sulfide, BOD, COD, phenol, and 4-methylphenol

- **Metals** — Arsenic, cadmium, mercury, and zinc

- **Organic Compounds** — polycyclic aromatic hydrocarbons (PAHs) and PCDDs/Fs (referred to collectively as chlorinated dioxins/furans).

Based on a rigorous evaluation of their potential risk to human health and ecological receptors (the results of which are described in more detail below), many of these CoPCs were screened out after the 1996 sampling effort and were not further evaluated in 1997.

In 1997, the CoPCs that were retained and evaluated included ammonia, sulfide, phenol, and

4-methylphenol. TOC, BOD, and COD, were also included as CoPCs; however, they were not considered problem chemicals or causative agents for toxicity. They were included as CoPCs because they are general indicators of elevated levels of organic matter, which can be harmful to bottom-dwelling marine animals.

Toxicity tests were performed on surface sediment samples from both phases of the sediment investigation. Four different sediment toxicity tests were used to characterize sediment in Ward Cove. Toxicity test results and measured CoPC concentrations were then used to derive site-specific sediment quality values for Ward Cove (WCSQVs) for certain chemicals.

During 1997, a detailed bathymetric survey, geophysical measurements (i.e., side-scan sonar and seismic reflectance to measure surface and subsurface sediment characteristics), current velocity measurements (at six locations, coupled with salinity/temperature measurements), and tidal observations were also made. This information was used to support modeling of the transport and fate of CoPCs in Ward Cove.

In 1998, KPC evaluated the feasibility and estimated cost of removing sunken logs from portions of Ward Cove. The primary purpose of that evaluation was to assess potential log removal actions that may complement proposed dredging efforts.

5.4 Nature and Extent of Contamination

Summary statistics (e.g., ranges, median and maximum concentrations, frequency of detection) for surface sediment results for both 1996 and 1997 are presented in Table 10. The concentrations of most of the CoPCs throughout large portions of the Cove exceed the concentrations found in Moser Bay, a nearby site used as a “background” reference point. The highest concentrations of many of the CoPCs were found near the former KPC facility and the fish cannery (see cannery location in Figure 3). There are differences from year to year in the distributions of some, but not all, CoPCs. The greatest differences occur for those CoPCs that may be susceptible to seasonal changes in biological activity (e.g., ammonia, 4-methylphenol). Concentrations of CoPCs in Ward Cove intertidal sediments, which occur only in a small area near the mouth of Ward Creek, were negligible.

Visual observations of surface sediment samples and deep sediment cores collected in Ward Cove and the associated chemical data indicate that impacts to sediment from activities at the former KPC facility, including historical releases of pulping by-products and log-handling activities, have resulted in a black, organic-rich layer of sediment that is distinctly different from underlying native sediments. This layer of sediment is concentrated near the head of the Cove offshore of the former KPC facility and along the north shore, and generally ranges in thickness from 2 to 10 ft, with some areas greater than 10 ft. This layer is distinguished from native sediment by higher concentrations of TOC, BOD, COD, ammonia, sulfide, phenol, and 4-methylphenol. The TOC content of this material was typically 20 to 40 percent, in contrast to native sediment that contains 0.36 to 12 percent TOC. A summary of subsurface sediment data collected in Ward Cove in 1997 (excluding native sediment samples) is presented in Table 11. A comparison of native and non-native subsurface sediment data collected in Ward Cove in 1997 is presented in Table 12.

The distribution of concentrations with depth in the sediment varied for different sets of CoPCs. Metals and dioxin/furan congeners are highest in surface sediment; TOC, BOD, and sulfide do not show any trends with sediment depth; and ammonia, phenol, and 4-methylphenol are highest in subsurface sediment.

Sediment toxicity tests, known as “bioassays”, are used as surrogates for predicting impacts to benthic communities. Results of sediment toxicity tests performed between 1989 and 1995 in Ward Cove were somewhat contradictory. Although all tests identified sediments immediately off the former KPC facility as being toxic, results for sediments from other portions of the Cove did not always agree. In the RI/FS, sediment toxicity measurements found toxicity in only two of the four toxicity tests. Most stations at which sediment toxicity was found were located offshore of the former KPC mill and downcurrent along the northern shoreline of Ward Cove. Complete details are provided in Section 7.2.

Ward Cove is a hydrologically quiescent environment, and there appears to be little transport of organic solids (TOC) or other CoPCs out of the Cove. Numerical modeling of CoPC transport and fate produces predictions of CoPC distributions that are consistent with the observed distributions. Future remobilization and redistribution of sediment materials is therefore not expected to alter the currently observed distribution.

Measured concentrations of chemicals in seafood collected within and near Ward Cove are discussed in Section 7.1 of the human health risk assessment, and results of standard and specialized sediment toxicity are discussed in Section 7.2 of the ecological baseline risk assessment.

6. CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

The current and planned future uses of the former KPC upland property, now owned by Gateway, consist of ongoing activities related to operation of the existing sawmill and proposed activities related to a green veneer mill that is scheduled to begin operations sometime in 2000. Gateway intends to produce lumber and veneer, chips for pulp, and hog fuel as a by-product. The upland property use is industrial/commercial and is expected to remain industrial/commercial.

KPC had been operating under an administratively extended individual National Pollutant Discharge Elimination System (NPDES) permit for the log transfer facility (LTF) located at the sawmill. Under EPA's authorization, KPC transferred the permit to Gateway. The permit authorizes the discharge of bark and other organic debris to Ward Cove in conjunction with operation of the LTF. The recently-issued general NPDES permit for Alaska LTFs and the accompanying State of Alaska Certificate of Reasonable Assurance imposes more stringent and comprehensive best management practices designed to minimize discharge, and subsequent deposition, of bark and other debris in Ward Cove. Development and implementation of these best management practices would help ensure long-term protectiveness of the Selected Remedy for the Marine OU.

The current and reasonably anticipated future use of the Marine OU has been considered to ensure, to the extent practicable, that Superfund response actions are consistent with anticipated productive uses of the Marine OU. The primary use within the Marine OU is navigation, and historical studies have shown that shallow sediments in the nearshore navigational areas are contaminated, and would likely require remediation. Anticipated future uses current and future land use information was provided by KPC and Gateway (the current owner of the site), and has been discussed with the Ketchikan Gateway Borough.

The evaluation of requirements for current and future commercial navigation within the Marine OU focused on the continued use of the existing deep draft dock facility (i.e., the main dock) and the planned development of a shallow draft barge facility by Gateway (Figure 10). The current and future use of the upland facility by Gateway (sawmill and veneer plant) will require access along the existing main dock to support vessels of approximately 650 ft in length and 100 ft in width, with drafts of 30 ft or less. To meet that requirement, the estimated navigational depth of sediments in the deep draft berth area near the main dock would be -40 to -44 ft MLLW. In addition, the planned development for a shallow draft barge berth area in the northeast corner of the Cove is estimated to require navigational depths of -14 ft MLLW based on log barges that are estimated to have drafts of approximately 12 ft. To the extent practicable, the remedy will include dredging of contaminated sediments consistent with these anticipated future uses.

KPC maintains ownership of the wood waste and ash disposal landfill located on Dawson Point. Currently one cell of the landfill remains in operation (under ADEC Solid Waste Permit No. 9713-BA001). However, it is anticipated that this cell will be closed in the future, in accordance with the ADEC solid waste permit and all applicable regulations. Long- term monitoring and inspection of the landfill (both the previously closed and active cells) are required under the permit. Landfill leachate is discharged after treatment through Outfall 001, a discharge that is authorized under the existing NPDES permit.

Current upland commercial/industrial uses near the KPC site, such as the cannery, are expected to continue, and potential future uses for the southern shore of the Cove may include such businesses as boat marinas and float plane docks. Other possibilities include a small hydroelectric facility operated by Ketchikan Public Utilities, a fish by-products processing facility, and other light industrial users that would take advantage of the industrial/commercial amenities offered by the upland property. With proper planning, all of these development possibilities could be integrated with the Selected Remedy that has been developed for Ward Cove. In addition, current recreational uses in Ward Cove, such as seasonal fishing at the mouth of Ward Creek, are expected to continue.

The listing of Ward Cove as a 303(d) water body is also relevant to future uses and development. Section 303(d) of the Clean Water Act requires states to identify water bodies that do not meet state clean water goals, called water quality standards. Ward Cove is on Alaska's 303(d) list of "impaired" water bodies because it does not meet Alaska's water quality standards for sediment toxicity, dissolved gas (oxygen is depleted in portions of the water column in the summer), and residue (sunken logs and bark debris are present on the bottom). As a result of performing the sediment remediation selected for the Marine OU, those areas in all of Ward Cove impacted by historical releases from the KPC facility are expected to attain the Alaska water quality standard for sediment toxicity (see fact sheet on Ward Cove water quality and 303(d) issues, ADEC and U. S. EPA 1998).

The listing of a water body on the 303 (d) list does not by itself prohibit the permitting of facilities that are expected to discharge into that water body, and options for future NPDES permitting in Ward Cove do exist. For example, if a new discharge from a facility does not affect a listed pollutant parameter, the facility could be issued a discharge permit in the same way that any other facility is issued a permit. If a new or existing discharge affects a listed pollutant parameter, then the amount of the pollutant that can be discharged will be allocated in a total maximum daily load. The first step ADEC takes to address a 303(d) listed water body is to assess the water body through the development of a water body recovery plan. ADEC plans to use the watershed approach for developing a Waterbody Recovery Plan for Ward Cove. This approach will involve broad public participation from citizens and stakeholders, including the Ketchikan Gateway Borough and other state and federal agencies.

7. SUMMARY OF SITE RISKS

This section summarizes the evaluation of site risks to humans and ecological receptors. The human health risk assessment is conducted to identify potential risks posed by chemicals detected in sediments or seafood from Ward Cove. The ecological risk assessment of Ward Cove sediments consisted of an assessment of sediment toxicity throughout the Cove and a food-web bioaccumulative assessment to estimate risks of chemicals in sediments to representative birds and mammals at the top of the Ward Cove food web.

7.1 Human Health Risks

This section of the ROD summarizes the results of the baseline human health risk assessment for the Marine OU of the KPC site. The baseline human health risk assessment was conducted to identify potential risks posed by chemicals detected in sediments or seafood from Ward Cove if no action were taken. Risk analyses were consistent with EPA guidance and incorporated fish and shellfish consumption rates that are representative of average consumption in a local subsistence fishing community (Wolfe 1995, pers. comm.; Freeman 1995, pers. comm.). In this summary, the potential for people to be exposed to chemicals detected in sediments or seafood is first evaluated, and seafood consumption is identified as the only complete exposure pathway. Subsequent sections describe toxicity data used in the evaluation and the screening of site data to determine whether any chemicals pose potential risks to human health. Despite the use of conservative screening methods, no CoCs were identified for human health.

7.1.1 Human Exposure Potential

Exposures are expected only where an exposure pathway is complete. Exposure pathways are considered complete when they have each of the following characteristics: CoPCs identified in an exposure medium (e.g., CoPCs in seafood tissues at concentrations exceeding background); an actual or hypothetical means that a receptor may come in contact with that medium (e.g., anglers who fish in affected areas within Ward Cove); and a route of exposure (e.g., consumption of seafood containing CoPCs). Where one of these elements is absent, the exposure pathway is considered not to be complete and no hazards are expected.

Human receptors may contact chemicals in Ward Cove sediments or seafood through the following hypothetical exposure pathways: 1) consumption of fish or shellfish that have bioaccumulated chemicals from sediments, and 2) direct contact with affected sediments through ingestion or dermal contact. Exposure to chemicals in fish or shellfish that have bioaccumulated these chemicals from sediments was identified as the only complete exposure pathway and was used as the basis to identify chemicals in sediments with the potential to pose risks to human health in both current and future scenarios. Exposure to site-related chemicals resulting from direct contact with sediments in Ward Cove is considered to be highly unlikely because of the depth of affected sediments and the cold climate. However, in response to community concerns, risk estimates for direct contact with sediments near the mouth of Ward Creek (an area used for recreational fishing and wading) were calculated and estimates were found to be well within acceptable levels [see Appendix H of the DTSR (Exponent 1999)].

Seafood consumption rates are difficult to identify precisely and may differ greatly between population groups. Conservative consumption rates for fish and shellfish were identified through discussions with the Alaska Department of Fish and Game (ADFG) and after review of available local and regional fish consumption rate data. Residents of the Ketchikan area include people who rely heavily on seafood in their diet (i.e., subsistence populations). Therefore, screening to identify CoPCs used conservative consumption rates of 65 g/ day of fish and 11 g/day of shellfish **1**, compiled in a data package provided by ADFG and described as representative of average seafood consumption rates for a subsistence community in the area. These rates were derived by ADFG by dividing the mean edible pounds of all the fish and shellfish**2** harvested per year in Saxman, Alaska, a predominantly Native Alaskan community, by the Saxman population. Use of harvest rate data to represent consumption rates is a conservative means to evaluate consumption because not all of the fish and shellfish harvested in the community would be consumed in that community.

> **1** Consumption of 65 g/day of fish and 11g/day of shellfish was used for all substances except polycyclic aromatic hydrocarbons (PAHs). The evaluation of PAHs was based on consumption of 11g/ day of shellfish only. Although PAHs may be taken up into fish, they also are rapidly metabolized and thus, do not readily bioaccumulate in fishes.
>
> **2** Fish consumption rates were based on harvest data for all fish. Shellfish consumption rates were based on the ADFG harvest category “Marine Invertebrates,” which included the following subcategories: abalone, crab, scallops, chitons, octopus, sea cucumber, sea urchin, shrimp, and “unknown”.

Use of average intake rates based on Saxman data provides a health- protective means to evaluate intake in the Ketchikan area because Saxman data are representative of a sensitive subpopulation (i.e., predominantly native groups) and the population in Ketchikan is both native and non-native. Although these subsistence level consumption rates are likely to greatly overestimate seafood consumption in the general population, they were used to provide a means to screen site data for CoPCs and CoCs for all hypothetical site users. It is also noted that Ward Cove is not designated for Customary and Traditional Use under Alaska State regulations, and Ward Cove is designated as a nonsubsistence area (ordinary fishing and gathering is allowed).

While seafood consumption rates may be relatively high for some communities within the Ketchikan area, Ward Cove is one of many fishing areas available to area residents. Fishing in the Ward Cove area primarily takes place at the outlet of Ward Creek, where anglers predominantly take salmon when they are present during 1-2 months of the year. Fishing from the shores of Ward Cove is limited due to steep slopes and a rocky shoreline, and log rafts and permanent structures in the Cove limit access to site areas by boat. Collection of shellfish is uncertain but is expected to be limited, primarily because the majority of Ward Cove is represented by subtidal habitat.

In screening site data for identification of CoCs, seafood consumption rates were combined with a fractional intake estimate of 5 percent (i.e., 0.05) to account for the availability of many more attractive alternative fishing locations in the area. This fractional intake estimate also accounts for the fact that salmon, the most popular fish species for human consumption in the area, are migratory, thus limiting (or eliminating) the opportunity for salmon to bioaccumulate chemicals from Ward Cove sediments. The fractional intake is not intended to account for any reduction in use of Ward Cove resulting from current conditions and instead is based only on geographic considerations and on the migratory nature of the primary fish caught in Ward Creek and Ward Cove.

The seafood consumption rates used are expected to overestimate exposures for most people who use Ward Cove; however, application of these consumption rates to the Ward Cove area provides a conservative means to evaluate risks.

7.1.2 Toxicity Assessment

The toxicity assessment consists of two components: hazard identification and dose-response evaluation. Hazard identification is the process of determining what adverse human health effects, if any, could result from exposure to a particular chemical, while the dose- response evaluation quantitatively examines the relationship between the level of exposure and the incidence of adverse health effects. Both carcinogenic and noncarcinogenic effects were evaluated in the human health risk assessment.

Toxicity values were used here in the identification of CoCs for human health. Specifically, toxicity values were used to derive risk- based concentrations used in screening site chemical concentrations to identify CoCs. The source of toxicity values used in this risk assessment was the EPA Integrated Risk Information System and the EPA Health Effects Assessment Summary Tables.

EPA-derived toxicity values used in risk assessments are termed carcinogenic slope factors and reference doses (RfDs). Slope factors are used to estimate the incremental lifetime risk of developing cancer corresponding to a specific exposure level calculated in the exposure assessment. For example, a risk estimate of one in a million represents one additional cancer expected over the background rate of cancer, which is about one in four (i.e., 250,000 per million). Excess cancer risk estimates are typically compared with acceptable risk ranges identified by regulatory agencies, The EPA Superfund program identifies a risk range of 1 in 1,000,000 to 1 in 10,000 (i.e., 1 x 10-6 to 1 x 10-4) as the acceptable range for excess cancer risk.

The potential for noncarcinogenic health effects is typically evaluated by comparing estimated exposure rates for a chemical with the respective RfD, which represents the daily intake at which no adverse effects are expected to occur over a lifetime of exposure. When the exposure is not greater than the RfD, no adverse effects would be expected from contaminant exposures at the site under the exposure conditions evaluated.

Table 13 shows the algorithm used to estimate human health risk-based screening concentrations in seafood tissue.

7.1.3 Identification of Chemicals of Concern

Potential human health risks associated with chemicals in Ward Cove sediments were evaluated using both estimated and measured concentrations of chemicals in seafood. For the human health risk assessment, the chemicals evaluated were arsenic, cadmium, mercury, zinc, phenol, 4-methylphenol, PCDDs/Fs, and PAHs. The human health risk assessment included any chemical detected in sediments that had an EPA-derived toxicity value (i.e, a RfD) or a carcinogenic slope factor) regardless of whether the chemical had a high potential to bioaccumulate in fish or shellfish that might be consumed by people. For example, although phenol and 4-methylphenol are not considered to be bioaccumulative c6mpounds, they were evaluated in the risk assessment because they had EPA toxicity values (a noncancer RfD) and so were included in the interest of completeness.

Human health risks were assessed in two ways: 1) by estimating seafood (fish, crabs, bivalves, shrimp, and gastropods) tissue chemical concentrations by applying biota-sediment accumulation factors (BSAFs[3]) to the maximum chemical concentrations observed in surface sediment, and, 2) by using measured tissue concentrations for PCDDs/Fs and mercury in seafood (fish, crabs, mussels, and clams) collected from Ward Cove and Tongass Narrows. The maximum bulk sediment chemical concentrations measured in Ward Cove and used in the BSAF approach are shown in Table 5, a complete summary (i.e., all station-specific data) of bulk sediment concentrations for those chemicals assessed in the human health risk assessment is provided in Section 7.2, and summary statistics for all measured bulk sediment chemical concentrations are provided in Table 10. Maximum measured tissue chemical concentrations are shown in Table 5. Seafood tissue concentrations, which were available from previous investigators, were available for PCDDs/Fs and total and methylmercury analyses in mussel and clam samples from Ward Cove and Tongass Narrows and results of PCDDs/Fs in crab and finfish samples collected in or near Ward Cove. Estimated tissue chemical concentrations were consistently higher than measured tissue chemical concentrations.

Maximum estimated or measured tissue concentrations were compared with available background concentrations for arsenic or PCDDs/Fs (no representative background tissue concentration data were identified for the other chemicals). Maximum estimated seafood concentrations for arsenic were lower than background concentrations identified in the contiguous United States. Maximum estimated and measured concentrations of PCDDs/Fs were elevated over background concentrations in tissues collected in Alaska.

Maximum estimated and measured tissue concentrations were also compared with risk-based screening concentrations for chemicals in seafood derived using EPA guidance and site-specific seafood consumption rates described above (Table 5). Although application of subsistence-level consumption rates greatly overestimates risks to the general population, these rates were used to provide a protective means of evaluating risks for all hypothetical current or future site users. For carcinogens, risk-based screening concentrations were calculated using a target risk level of 1 x 10-5, which is more conservative than the lower end of EPA’s acceptable risk range for Superfund sites (EPA’s acceptable risk range is 1 x 10-4 to 1 x 1 x 10-6). Thus, use of this target risk level incorporates a measure of protection for exposure to carcinogens at the site. Consistent with EPA and ADEC guidance, risk-based screening concentrations for noncarcinogenic CoPCs were derived with a hazard index of 1.

3 A biota-sediment accumulation factor (BSAF) is a ratio of the relative concentration of a substance in the tissues of an aquatic organism compared to the concentration of the same substance in the sediment. In applying the BSAF for organic chemicals, concentrations in sediments are corrected for total organic carbon (TOC) content and concentrations in fish are corrected for lipid content. Given chemical concentrations in sediments, BSAFs can be used to estimate concentrations of those same chemicals in the tissues of organisms.

Sources of uncertainties inherent in the human health risk assessment include key factors related to toxicity values, seafood consumption rates, and exposure durations. Although there are uncertainties associated with these risk estimates, assumptions used tend to overestimate, rather than underestimate risks. A complete discussion of these uncertainties is provided in Appendix H of the DTSR and in Section 6 of the Responses to Comments on the DTSR. Risk-based screening concentrations were calculated for all chemicals that had EPA-derived toxicity values. As requested by the community, the effects of applying an alternative fractional intake estimate of 10 percent and a 70-year exposure duration are discussed in Appendix G of the DTSR.

Although some detected chemicals associated with wood products could not be included in the screening because of the lack of EPA-derived toxicity values, these detected compounds were present at concentrations much lower than risk-based screening concentrations for other non- chlorinated organic chemicals such as methylphenol, naphthalene, or pyrene that have a similar chemical structure. Human health risks associated with these compounds are expected to be minimal.

7.1.4 Human Health Risk Conclusions

Despite the use of conservative screening methods, estimated tissue concentrations (using the BSAF approach) exceeded risk-based screening concentrations only for PCDDs/Fs (Table 5). The maximum estimated seafood tissue concentration of 3.9 x 10-5 mg/kg wet weight was approximately 13 times higher than the risk-based screening concentration of 3.0 x 10-6 mg/ kg wet weight and thus would be identified as a CoC on this basis. In contrast, the maximum measured seafood tissue PCDD/F concentration (expressed as toxic equivalent concentration [TEC]) of 0.78 x 10-6 mg/kg wet weight was lower than the risk-based concentration for PCDDs/Fs (TEC). Measured tissue concentrations are a more reliable basis for identifying CoCs than estimated tissue concentrations because of the uncertainty in applying BSAF estimates. BSAF-derived estimates also represent whole-body concentrations, which tend to overestimate concentrations in tissues consumed by people. Thus, given consideration of both the estimated and measured tissue concentrations, no CoC were identified for human health. Thus, risks to humans appear to be within levels considered acceptable by regulatory agencies.

Cumulative risk estimates for individuals who might be exposed to chemicals in both upland media and Ward Cove media were derived during the process of selecting remedial actions and evaluating residual risks for the Upland OU. Thus, exposure and risk for a resident who might work at the former mill site and eat fish and shellfish from Ward Cove was assessed. The results of this supplemental risk assessment, documented in the Uplands OU Administrative Record, indicated that no new actions are needed beyond those identified based on the Uplands and Marine OUs to be protective of human health.

7.2 Ecological Risks — Sediment Toxicity

The objective of the sediment toxicity assessment was to identify CoPCs in Ward Cove that pose potential risks to organisms that live within or on the surface sediments of the Cove. The assessment was based primarily on two kinds of information collected at 44 stations in Ward Cove: 1) concentrations of CoPCs in Ward Cove sediments that present a risk to benthic organisms (Tables 2-4), and 2) results of four kinds of sediment toxicity tests conducted in a laboratory by exposing four different sensitive and representative marine test animals to sediment from the bottom of Ward Cove (Tables 6 and 7), For each station at this site, surface sediments (i.e., the top 10 cm) were collected and analyzed because bottom- dwelling organisms (e.g., worms, clams), known as the “benthic community,” live only in these upper sediments; benthic organisms do not live in the deeper sediments. Based on results of a detailed reference area evaluation, Moser Bay, Alaska (located within 25 km of Ward Cove) was selected as the reference area for evaluating significance of the sediment toxicity results, and two stations were sampled in that embayment. Information on sediment chemistry and sediment toxicity was collected in two phases. Phase 1 was conducted during 1996 (28 stations in Ward Cove and the 2 reference stations in Moser Bay), and Phase 2 was conducted in 1997 (33 stations in Ward Cove and 2 reference stations in Moser Bay).

Sediment toxicity tests, known as “bioassays”, are used as surrogates for predicting impacts to benthic communities. These bioassays directly measure sediment toxicity by exposing marine animals to site sediments in a laboratory. At this time, standardized bioassay tests are generally used by EPA to identify the extent and severity of sediment contamination. Standardized sediment toxicity tests have been found to be robust, adequately sensitive, and field-validated over a range of environmental conditions. Given the physical features and site-specific conditions of Ward Cove, EPA believes that sediment toxicity testing, and not direct measurements of benthic communities, is appropriate for identifying sediments that warrant remediation.

At this site, four sediment toxicity tests were used to characterize sediments in Ward Cove, as follow:

- The 10-day amphipod test using Rhepoxynius abronius (acute test)

- The 10-day amphipod test using Leptocheirus plumulosus (acute test)

- The 96-hour echinoderm embryo test using the sand dollar Dendraster excentricus (acute test)

- The 20-day juvenile polychaete test using Neanthes sp. (chronic test).

The endpoint for the two amphipod tests was percent survival, and the endpoint for the juvenile polychaete test was growth. The primary endpoint for the echinoderm embryo test was percent normal survival, and a secondary endpoint was percent normality of surviving embryos.

Sediment toxicity to benthic communities may affect the wider community because bottom-dwelling animals are a food source to larger invertebrates and fishes. Although this pathway was not directly evaluated, it is recognized that if the toxicity of sediments affects the numbers or types of bottom-dwelling animals living in the sediments, then those changes in the structure of the benthic community may alter the feeding strategies of larger invertebrates and fishes.

7.2.1 Determining Significance of Sediment Toxicity Test Results

There are no promulgated federal or Alaska chemical or biological cleanup standards for marine sediments. More specifically, there are no federal or Alaska promulgated standards for the protection of benthic communities in marine sediments. For this site, significance of the sediment toxicity test results was determined using methods consistent with those of the Washington State sediment management standards (SMS), which are the only existing promulgated marine sediment standards in the United States. The SMS includes biological standards for the protection of benthic communities in marine sediments. Although neither Alaska nor EPA have a requirement or policy that the Washington State approach must be followed for problem sediment projects in Alaska, portions of the Washington State SMS were used for this site because they are considered environmentally protective and they have received extensive scientific and public review. Further, they have some natural applicability to the marine waters of Ward Cove because they are considered protective of Puget Sound, Washington, marine species, many of which are also found in southeast Alaska, including Ward Cove.

The Washington State SMS identify two levels of biological criteria for the protection of benthic communities in sediments. The most stringent level, the sediment quality standard (SQS), corresponds to the state’s long-term goal of “no adverse effects”, and is used to evaluate whether sediments may be toxic and therefore warrant further investigation. The less stringent level, the minimum cleanup level (MCUL), corresponds to “minor adverse effects” and is used in remediation evaluations. Using the SMS approach, the SQS and MCUL screening values for the present study are as follows (see Tables 6 and 7):

- **Amphipod Test**

  - **SQS**: 75 percent survival (for both amphipod tests)

  - **MCUL**: 62 percent survival (*Rhepoxynius abronius* in 1996), 66 percent survival (*Rhepoxynius abronius* in 1997), 69 percent survival (*Leptocheirus plumulosus)*

- **Juvenile Polychaete Test**

  - **SQS**: 0.42 mg/day growth rate

  - **MCUL**: 0.30 mg/day growth rate

- **Echinoderm Embryo Test**

  - **SQS**: 72 percent normal survival (in 1996), 63 percent normal survival (in 1997)

  - **MCUL**: 59 percent normal survival (in 1996), 52 percent normal survival (in 1997).

7.2.2 Results of Sediment Toxicity Tests

Results of the four sediment toxicity tests are shown in Tables 6 and 7. Stations locations are shown in Figures 6 and 7.

Summaries of the significance determinations for the toxicity results are presented in Tables 6 and 7. No sediment samples exceeded SQS or MCUL values for the amphipod test using *L. plumulosus* or for the juvenile polychaete test. Thus, results from those two tests suggest that sediments are not toxic. By contrast, SQS and MCUL values were exceeded at various stations for the amphipod test using *R. abronius* and the echinoderm embryo test based on normal survival. Responses exhibited by the echinoderm. test based on embryo normality (an endpoint that is different than “normal survival”) generally were similar to responses found for Moser Bay for all samples collected in Ward Cove. For the *R. abronius* amphipod and the echinoderm, tests, SQS and MCUL exceedances were generally found at stations located near the former KPC facility and downcurrent from the facility midway along the northern shoreline of Ward Cove (Figures 11 and 12).

7.2.3 Development of Site-Specific Sediment Quality Values

Sediment quality values (i.e., numerical bulk sediment chemical concentrations) were used to identify stations in Ward Cove at which potential sediment toxicity would be predicted based on measured concentrations of various chemicals. The Washington State SMS chemical standards, which are based on the apparent effects threshold (AET) approach[4], were used for evaluation of most chemicals. The Washington State SQS, which corresponds to the state’s long- term goal of “no adverse effects”, is based on the lowest AET value for a range of biological indicators, whereas the MCUL, which corresponds to “minor adverse effects”, is based on the second lowest AET value observed for the indicators.

4 A chemical-specific apparent effects threshold (AET) value is defined as the concentration above which adverse biological effects are always observed for a particular data set. AET values can be developed for a range of biological indicators (e.g., sediment toxicity, benthic community analyses). The AET approach has been endorsed by EPA’s Science Advisory Board as a valid method for developing site-specific sediment quality values.

For those chemicals without Washington State chemical standards (i.e., TOC, total ammonia, BOD, and COD), WCSQVs were developed using Ward Cove data and the AET approach. Although a Washington State sediment management standard exists for 4-methylphenol, site-specific WCSQVs were developed for that chemical because concentrations measured in Ward Cove sediments exceeded the range of 4-methylphenol concentrations used to develop the standards in Washington State (for additional information see U. S. EPA (1999a),

Response to Comment 52). Although Washington State sediment management standards are not available for total sulfide, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), or TCDD TEC, WCSQVs were not developed for those chemicals because: 1) for total sulfide, there was analytical uncertainty for the sulfide concentrations measured in bulk sediments collected from Ward Cove, and the toxicological significance of bulk sediment concentrations of total sulfide is questionable; and 2) for dioxin/furans, the primary ecological concern for 2,3,7,8-TCDD and TCDD TEC is bioaccumulation in the food web, rather than direct toxicity to benthic macroinvertebrates, and further, 2,3,7,8-TCDD was detected at only 4 of the 25 stations evaluated in the Cove, which does not support adequate development of a site-specific AET value.

Two kinds of site-specific WCSQVs were developed. The WCSQV(1) (analogous to the Washington State SQS) was based on the lowest AET values for all four sediment toxicity tests evaluated in Ward Cove. The WCSQV(2) (analogous to the Washington State MCUL) was based on the second lowest AET value for the four toxicity tests. Summaries of all test results used to determine site-specific AET values for TOC, total ammonia, BOD, COD, and 4-methylphenol are shown in Tables 14 through 18.

The chemical concentrations in Ward Cove sediments are compared with sediment quality values in Tables 2–4. In general, the observed exceedances of sediment quality values were largely confined to within 300–400 m offshore from the former KPC facility and downcurrent from the facility midway along the northern shoreline of the Cove. Most exceedances of sediment quality values were found for ammonia (13 stations) and 4-methylphenol (18 stations).

7.2.4 Comparison of Sediment Toxicity and Sediment Chemistry Results

Potential relationships between results of the two sediment toxicity tests that exhibited adverse responses in Ward Cove (i.e., the amphipod test using *R. abronius* and the echinoderm embryo test based on normal survival) and the concentrations of each chemical were evaluated using the Spearman rank correlation coefficient, to infer which chemicals warranted further consideration with respect to the observed sediment toxicity.

The variables that exhibited the strongest correlations were *R. abronius* survival and sediment concentrations of total ammonia and 4-methylphenol. Normal survival of echinoderm, embryos did not exhibit a strong relationship with any of the chemicals. The strong negative relationship between *R. abronius* survival and total ammonia in Ward Cove sediments was also found for total ammonia in the overlying water and pore water of the toxicity test chambers. In addition, porewater concentrations of sulfide in the toxicity test chambers showed a strong negative correlation with amphipod survival.

The results of the correlation analysis indicated that ammonia, sulfide, and 4-methylphenol were potentially related to the observed patterns of amphipod survival in Sediments from Ward Cove. Those chemicals were therefore evaluated further.

7.2.5 Results of Specialized Toxicity Tests

Four kinds of specialized toxicity tests were conducted to further evaluate the potential roles of ammonia and sulfide in causing sediment toxicity in Ward Cove. Sediments from eight representative stations in the Cove were used in these evaluations. The four specialized tests included the following:

- Sediment purging procedure
- Sediment *Ulva* procedure
- Porewater *Ulva* procedure
- Porewater aeration procedure.

The primary test species for all four procedures was the amphipod *R. abronius*.

The results of the four specialized toxicity tests suggested that sulfide, rather than ammonia, was the primary cause of the observed sediment toxicity. Because both chemicals covaried, it was difficult to determine their independent contributions to toxicity. However, sulfide appeared to be the major cause of toxicity because porewater concentrations in most samples substantially exceeded the 48-hour LC50 for *R. abronius*, and because simple aeration of pore water (and the resulting oxidation of sulfide) eliminated toxicity in all but one sample. By contrast, porewater ammonia concentrations generally were lower than the 96-hour LC50 for *R. abronius*, and toxicity did not respond as strongly to reductions in ammonia concentrations as it did to reductions in sulfide concentrations.

Although the primary chemicals evaluated during the specialized toxicity tests were ammonia and sulfide, it is possible that other chemicals such as 4-methylphenol and other components of wood leachate may have been responsible for some of the observed toxicity. However, only sulfide has sufficient volatility and oxidizes rapidly enough to account for the change in toxicity observed following the aeration procedure.

The implication based on the specialized toxicity tests that sulfide was largely responsible for the observed toxicity is consistent with results of the four sediment toxicity tests used to characterize sediments throughout Ward Cove. Specifically, the unusual pattern of two tests exhibiting toxic responses (i.e., the *R. abronius* test and the echinoderm embryo test based on normal survival) and two tests showing no toxic responses (i.e., the *L. plumulosus* test and the juvenile polychaete test) is consistent with sulfide being the primary toxicant, given the different life histories of the test species.

Because *L. plumulosus* and *Neanthes sp.* live in tubes, they have an enhanced ability to isolate themselves from ambient sediment by controlling the diffusion rate of porewater solutes into the tube environment. In addition, by aerating the water in their tubes, organisms can effectively isolate themselves from oxidizable porewater constituents such as sulfide. By controlling the microenvironments within their tubes, many tubicolous organisms can inhabit sediments that are toxic to free-burrowing organisms such as R. abronius. This ability partly accounts for the fact that the first organisms to colonize many disturbed sediments are generally small, opportunistic, tube-dwelling polychaetes, followed by tube-dwelling amphipods.

7.2.6 Sources of Uncertainty

Sediment toxicity risks to ecological receptors may be either over-or underestimated based on several factors, including the selection of CoPCs, representativeness of sampling locations, representativeness of toxicity test species, accuracy of the laboratory bioassays in predicting impacts to in situ receptors, appropriateness of the reference area selected for comparison with site-specific sediment toxicity results, and accuracy of the weight-of-evidence approach used to delineate the AOC (see Section 8.0). Given the knowledge on the types of possible contaminant sources and the extensive list of target analytes measured in the Phase 1 sampling effort, and the use of specialized toxicity tests to address potential causative agents, it is likely that the CoPCs and the CoCs have been adequately evaluated. Similarly, the phased approach to the RI/FS sampling allowed for any data gaps related to the spatial representativeness of initial sampling locations to be addressed during subsequent sampling efforts. The number of toxicity test species (i.e., two amphipods, one worm, one echinoderm) used in the sediment toxicity assessment should address some concerns about the representativeness of test species. The use of multiple environmental indicators to evaluate sediment toxicity using a weight-of-evidence approach enhances confidence that toxic sediments are identified and that any observed toxicity is likely the result of chemical toxicity, rather than experimental artifacts or non-chemical factors such as habitat variables.

7.2.7 Summary of Ecological Risks Based on Sediment Toxicity

The results of the sediment toxicity assessment for Ward Cove surface sediments can be summarized as follows:

- Sediment toxicity was found in only two of the four toxicity tests used to evaluate Ward Cove sediments: the amphipod test using *R. abronius* and the echinoderm embryo test based on the normal survival endpoint. No sediment toxicity was found at any station for the other two toxicity tests.

- Most stations at which sediment toxicity was found and at which chemicals exceeded sediment quality values were located offshore from the former KPC facility and downcurrent from the facility along the northern shoreline of the Cove.

- Most exceedances of sediment quality values were found for ammonia (13 stations) and 4-methylphenol (18 stations).

- There are no “hot spots” of contamination (i.e., there is not a small portion of the sampled area that contains most of the mass of CoCs).

- *R. abronius* survival exhibited strong negative relationships with three chemicals: total ammonia, total sulfide, and 4-methylphenol.

- Results of four specialized toxicity tests that preferentially removed ammonia or sulfide from sediments sampled from eight representative stations in the Cove suggest that sulfide was the primary cause of the observed sediment toxicity.

- The implication of the specialized toxicity tests that sulfide was the primary cause of the observed toxicity is consistent with results of the four sediment toxicity tests used to characterize sediments throughout the Cove.

- Sediment CoCs identified as a result of the standard and specialized sediment toxicity tests were ammonia, sulfide, and 4-methylphenol (Table 1). Ammonia, sulfide, and 4-methylphenol are not considered bioaccumulative chemicals.

7.3 Ecological Risks — Food-Web Assessment

The food-web assessment evaluated whether chemicals in the sediments of Ward Cove posed a potential risk of adverse effects to key ecological receptors in the food web of the Cove. To be conservative in its estimation of potential risks, the assessment focused on the birds and mammals found at the top of the site-specific food web, because they were considered to be at greatest risk from bioaccumulation in the Cove food web. The species evaluated were two mammals, the harbor seal and river otter, and two sea birds, the marbled murrelet and pelagic cormorant. These species were selected primarily because they are upper trophic level species whose habitat-use characteristics suggest they have the highest potential for exposure to bioaccumulative chemicals in Ward Cove, and thus an assessment for these species would be protective of other bird and mammal species that potentially occur in Ward Cove, including threatened and endangered species.

7.3.1 Identification of Chemicals of Potential Concern for Ecological Risk

From the standpoint of bioaccumulation, the CoPCs in Ward Cove were identified as total mercury and PCDDs/Fs, expressed as TCDD TECs. However, several additional chemicals were evaluated in food- web exposure models because they were found at elevated concentrations (relative to reference conditions) throughout relatively large areas of the Cove. These additional chemicals were arsenic, cadmium, zinc, and PAHs. Several other chemicals were found at elevated concentrations in Cove sediments (i.e., phenol, 4-methylphenol, benzoic acid, and pulp mill compounds), but they were not considered in the food- web assessment because their distribution was highly localized, they have rarely been addressed in food-web assessments in other studies, and there is little information in the literature regarding their bioaccumulation potential.

7.3.2 Exposure Assessment

The primary route of exposure to chemicals in Ward Cove sediments for upper trophic level receptors is via ingestion of prey species that have bioaccumulated those chemicals in their tissues. In the exposure assessment, estimates were made of daily intake of chemicals by each receptor as a result of exposure through the food web. Exposure to chemicals was expressed as a total daily dose for each ecological receptor and was estimated based on the characteristics of each chemical and natural history traits of each receptor that influence their extent of exposure, such as diet composition, food ingestion rate, and foraging range. Concentrations of CoPCs in the prey of each receptor were estimated through application of BSAFs to the maximum and mean concentrations of chemicals detected in sediments in the Cove. Prey species that were used in exposure models were fish, crabs, shrimp, bivalves, and gastropods. Incidental sediment ingestion was included in the food-web models, with each ecological receptor assumed to ingest sediment while foraging at a rate of 2 percent of its daily food ingestion rate.

7.3.3 Toxicity Assessment

The assessment endpoints for the risk evaluation were selected to assess the probability of adverse effects through the food web to higher trophic level consumers. Specifically, the assessment endpoints were the protection and population maintenance of marine mammals and birds inhabiting the Cove. These assessment endpoints were addressed by food-web exposure modeling using the four receptor species. Daily dietary doses of CoPCs estimated for receptor species in the exposure assessment were compared with toxicity reference values (TRVs), which represented threshold daily doses below which exposure would not pose a risk of adverse effects. TRVs were obtained from studies in the literature in which a chronic no-observed-adverse-effect level was measured or estimated on the basis of a relevant ecological endpoint (i.e., reproduction, mortality). TRVs were available for all CoPCs except for PAHs for birds.

7.3.4 Risk Characterization

In the risk characterization, the results of the exposure and effects assessments were combined to estimate the risks to avian and mammalian receptors from CoPCs in the tissues of prey species and in sediments. Risks were presented as hazard quotient values, which were calculated for each CoPC by dividing the total daily dietary dose by the appropriate TRV. Hazard quotients less than 1.0 indicate that a CoPC is unlikely to cause adverse ecological effects, given the conservative assumptions used in the food-web exposure models. A hazard quotient greater than 1.0 indicates that the exposure for the modeled receptor exceeded the TRV. If the exposure exceeds the TRV, then there is a potential that some fraction of the population may experience an adverse health effect as a direct result of the presence of the CoPC.

Food-web exposure models indicate that harbor seals and pelagic cormorants are not at risk of adverse effects from exposure to any CoPC in Ward Cove (Table 8). For river otters, a risk of adverse effects may exist from exposure to PCDDs/Fs, because the hazard quotient exceeds 1.0 based on the maximum sediment concentration, although not when based on the mean sediment concentration. For marbled murrelets, a risk of adverse effects may exist from exposure to cadmium, because the hazard quotient exceeds 1.0 based on the maximum sediment concentration, although not when based on the mean sediment concentration. However, evaluation of some of the uncertainties associated with the assessment suggest that these risks may be overestimated in the modeling approach used for Ward Cove. Recalculations of hazard quotients for PCDDs/Fs using limited historical bioaccumulation data collected for several prey species at Ward Cove indicates that the BSAF approach overestimated risks to avian and mammalian receptors between 30- and 70-fold and that the actual risk quotient for all receptors was substantially less than 1.0. Similarly, historical data on bioaccumulation of mercury by mussels and clams suggest that the BSAF approach overestimated exposures to metals through the food web by up to 10-fold. If true, these recalculations would result in hazard quotients substantially less than 1.0 for PCDDs/Fs and cadmium for mammalian and avian receptors. Exposure models, when evaluated in consideration of the identified uncertainties in the modeling approach, suggest that no risks of adverse effects result from exposure to CoPCs through the food web for mammalian and avian receptors at Ward Cove.

Avian risk of adverse effects from exposure to PAHs could not be estimated quantitatively because no TRV was available for comparison with the daily exposure dose. However, fish and crustaceans, the major prey sources of birds evaluated in the food-web models, are efficient at metabolizing PAHs and exhibit bioaccumulation of these compounds only in heavily polluted areas (Albers 1995). Concentrations of PAHs in sediments at Ward Cove were very low, with no individual PAH having a maximum concentration greater than 2 mg/kg dry weight. Furthermore, trophic level increases in accumulation of PAHs have not been observed in aquatic ecosystems, which suggests that exposure of birds to PAHs through the food web is minimal and unlikely to constitute a significant risk.

As a supplemental evaluation to determine if PCDD/F concentrations in Ward Cove sediments were protective of bioaccumulative effects to higher trophic-level organisms, potential effects of 2,3,7,8-TCDD, the most potent dioxin congener, on early life stages of fish (eggs and embryos) were evaluated using a simple maternal-egg transfer model. The model was based on data for lake trout, a species known to be sensitive to the early life-stage effects of TCDD. Because early life stages of fish are generally more sensitive than older individuals to the effects of TCDD, this approach was also protective of adult benthic and demersal fishes.

Studies indicate that on a wet-weight basis, the TCDD concentration in lake trout eggs is about 30-40 percent of the maternal concentration (U. S. EPA 1993). Using a no-observed-adverse-effect level of 3.5 x 10-5 mg/kg wet weight TCDD TEC for mortality in lake trout fish eggs (Walker et al. 1991) and a maternal- egg transfer ratio of 0.40 (40 percent), this no-effect tissue concentration in eggs corresponded to 8.5 x 10-5 mg/kg wet weight TCDD TEC in the parent fish. Based on a fish lipid proportion of 0.102, which was the value used for the Ward Cove food-web assessment, the corresponding maternal lipid-normalized TCDD TEC was 8.3 x 10-4 mg/kg. Dividing the lipid-normalized concentration by 1.04 (the BSAF value for fish that was used in the Ward Cove ecological assessment) resulted in a TOC-normalized sediment TCDD TEC of 8.0 x 10-4 mg/kg, which would be protective of fishes. The maximum TOC-normalized TCDD TEC in Ward Cove sediments was 4.6 x 10-4 mg/kg, based on a maximum sediment dry weight concentration of 4.6 x 10-5 mg/kg and 10 percent TOC, which is below the calculated threshold criterion. These results indicate that concentrations of PCDDs/Fs in Ward Cove sediments should not be of concern for fish or other higher trophic-level organisms.

7.3.5 Sources of Uncertainty

The hazard quotients reported in the food-web assessment must be considered with regard to the uncertainty associated with the parameters evaluated as part of the model. There were several sources of uncertainty in the estimation of risks for this ecological assessment, and the actual risks may have been higher or lower than predicted. Uncertainties existed particularly with regard to the use of TRVs derived from studies with laboratory species that may not have reflected the sensitivity of receptor species evaluated in the exposure assessment and with the use of a literature-derived BSAF approach to estimate chemical concentrations in prey tissue from the concentrations measured in sediment.

TRVs were not available for the wildlife species evaluated in the risk assessment, and values derived from laboratory studies for other species were used instead. This approach increased uncertainty because the magnitude and direction (more or less sensitive) of differences among the species in sensitivity to the toxic effects of the CoPCs are not known. To account for differences in toxicity to chemicals among species, numeric uncertainty factors based on the taxonomic divergence between test species and the wildlife receptors evaluated in the food-web models are sometimes applied. This uncertainty factor approach is designed to ensure a conservative result. The magnitude of the interspecies uncertainty factor is proportional to the perceived uncertainty as gauged by the phylogenetic distance between the test and receptor species. Interspecies uncertainty factors were not applied in this risk assessment. This approach is consistent with other ecological risk assessments that have been performed at sediment sites in Region 10. However, if the risk assessment had used an uncertainty factor scaling approach as described by EPA Region 10 guidance (U. S. EPA 1997), hazard quotients for receptors in Ward Cove would have been four-fold higher than reported, based on either maximum or mean CoPC concentrations in sediment. In all cases, however, the hazard quotients would be less than 10, and considering the uncertainty surrounding derivation of hazard quotients, risks to receptors were considered not likely to be significant.

Finally, several chemicals found at elevated concentrations in Ward Cove sediment (i. e., phenol, 4-methylphenol, benzoic acid, and pulp mill compounds) were not evaluated for risk in the food-web assessment. The distribution of these compounds was highly localized within Ward Cove, and thus they are not likely to be of concern for the mammalian and avian receptors that have expansive foraging ranges both within the Cove and in surrounding areas. Little information exists in the literature regarding the bioaccumulation potential of these compounds, but they have rarely been addressed in food- web assessments in other studies, and they are not generally considered compounds that pose a risk via accumulation through the food web. Thus, although these CoPCs were not evaluated, their limited distribution and low likelihood of bioaccumulation suggest that they are unlikely to represent a significant risk for wildlife (bird and mammal) receptors in Ward Cove.

7.3.6 Summary of Ecological Risks Based on Food- Web Assessment

Exposure models, when evaluated in consideration of the uncertainties identified in the modeling approach, indicate that no risks of adverse effects resulted from exposure to CoPCs through the food web for avian or mammalian receptors at Ward Cove. In addition, the maternal-egg transfer model used to evaluate potential effects on fish indicated that concentrations of PCDDs/Fs in Ward Cove sediments do not pose a risk to fish inhabiting the Cove.

8. REMEDIATION OBJECTIVES

The baseline human health and ecological risk assessments culminated in the identification of the Area of Concern for sediments in the Marine OU where remediation may be warranted. In these risk assessments, the chemicals present in the surface sediments of Ward Cove were evaluated to determine potential human health and ecological risks from direct exposure and exposure via the food web. The risk evaluations considered in detail three major types of exposure pathways:

- Human exposure to CoPCs through seafood consumption
- Wildlife (bird and mammal) exposure to CoPCs through seafood consumption
- Benthic organism exposure to CoPCs through direct contact.

Additional secondary exposure pathways (e.g., direct contact with sediments by humans) were evaluated as part of the sensitivity analyses of these risk assessments.

The risks associated with the first two types of exposure were determined to fall within acceptable limits when considered in the context of the conservative modeling assumptions (see Sections 7.1 and 7.3). However, sediment toxicity is present in portions of the Cove at levels that warrant consideration for sediment remediation (see Section 7.2). Thus, the response action selected in this ROD is necessary to protect the environment from actual or threatened releases of hazardous substances into the environment. Such a release may present an imminent and substantial endangerment to the environment.

8.1 Remedial Action Objectives

Superfund regulations require that RAOs be established for a site (40 CFR 300.430 (e)(2)(i)). RAOs provide a general description of what the remediation will accomplish (e.g., protect the environment by reducing sediment toxicity levels, as appropriate). The RAOs are EPA's goals for addressing risk at the site. Thus, in Superfund, RAOs are established only for those pathways for which risk had been identified as exceeding acceptable levels. RAOs were established for Ward Cove based on an ecological evaluation of toxicity to the benthic community in surface sediments. Toxic effects appear to be related to non-persistent by-products from the decomposition of organic matter that settled on the Cove bottom primarily as a result of pulping effluent discharges from the former KPC mill. Attainment of the RAOs will significantly reduce toxic effects to the benthic community in surface sediments. At this site, surface sediments are defined as the top 10 cm because benthic organisms live only in these upper sediments.

The RAOs for surface sediments in the AOC are to:

- Reduce toxicity of surface sediments

- Enhance recolonization of surface sediments to support a healthy marine benthic infauna community with multiple taxonomic groups.

A benefit of achieving these RAOs is that a healthy benthic infaunal community serves as a diverse food source to larger invertebrates and fishes. The response action selected in this ROD will achieve these RAOs. It is expected that RAOs will be met over various time periods, depending on the location within the AOC and the component of the remedy being implemented in the location (e.g., active remediation vs. natural recovery).

There are no applicable or relevant and appropriate requirements (ARARs) that are driving selection of the remedy at this site. Specifically, there are no promulgated federal or Alaska cleanup standards for marine sediments. Instead, the need for a response action is being driven by sediment toxicity to representative benthic infaunal organisms. The sediment quality values that were used to determine which areas of Ward Cove required remediation are based on the results of sediment toxicity tests and bulk chemistry data for surface sediments, portions of the State of Washington's sediment management standards chemical and biological criteria (which are the only existing sediment standards in the United States), and site-specific sediment quality values that were developed for selected chemicals using biological and chemical data for Ward Cove and using methods consistent with those used to develop the Washington State sediment management standards (see Section 7). Although neither Alaska nor EPA have a requirement or policy that the Washington State approach must be followed for contaminated-sediment projects, portions of the State of Washington's sediment management standards were used for this site because they are considered environmentally protective, are familiar to EPA, and have received extensive scientific and public review. Further, ADEC used the Washington State Sediment Management Standards in evaluating the nature and extent of sediment contamination at the Alaska Pulp Corporation Site in Sitka, AK. Finally, they have some natural applicability to the marine waters of Ward Cove because they are considered protective of marine species found in Puget Sound, Washington, many of which are also found in southeast Alaska, including Ward Cove.

Although site-specific bulk sediment chemistry values were developed for Ward Cove for selected chemicals and were used as one component of the sediment toxicity assessment, chemical-specific bulk sediment criteria are not being established as cleanup levels for the CoCs at this site. The CoCs at this site (ammonia, sulfide, and 4-methylphenol) are non- persistent products of organic matter degradation. The dissolved form of these chemicals is the toxic form, and dissolved concentrations are expected to have strong variability both spatially (horizontally and with depth) and temporally. Dissolved sulfide, the most likely candidate for causative agent, cannot be adequately characterized by bulk chemistry measurements of sulfide and it is not practical, efficient, or ecologically relevant to monitor sulfide in pore water, given its high spatial and temporal variability. Given the transient nature of the causative agents and the difficulty in establishing their direct link to toxicity and community impacts, it was concluded that the success of the remedy would be best measured by those indicators most directly representative of RAOs, i.e., sediment toxicity and the health of benthic infauna. Thus, site-specific biological criteria for sediment toxicity and the health of benthic infauna will be established to evaluate the protectiveness of the Selected Remedy and the rate at which the RAOs are being achieved. The specific measurement endpoints for these biological criteria will be established pursuant to the Monitoring and Reporting Plan, a required deliverable under the Superfund Consent Decree. Biological measurements, including assessments of sediment toxicity and benthic community composition, will be evaluated as part of the long-term monitoring effort of the Selected Remedy.

8.2 Delineation of Area of Concern

The sediment toxicity ecological evaluation culminated in the identification of an AOC, which represents that portion of the Marine OU where the Selected Remedy will be implemented because surface sediments impacted by historical releases from the KPC facility pose a risk to benthic organisms. This section describes the approach used to delineate the boundaries of the AOC.

As documented in Section 7.2, the most likely causative agents of sediment toxicity in Ward Cove appear to be ammonia, sulfide, and 4-methylphenol, the CoCs for Ward Cove sediments. Ammonia, sulfide, and 4-methylphenol are hazardous substances under CERCLA regulations. However, to be conservative, the delineation of the AOC was based on all Phase 2 CoPCs, except total sulfide (i.e., TOC, total ammonia, BOD, COD, and 4-methylphenol). The delineation was not based on total sulfide because there was analytical uncertainty for the sulfide concentrations measured in bulk sediments, and there were no sediment quality values available for that chemical.

A weight-of-evidence approach was used to delineate the AOC on the basis of the kinds of exceedances of sediment toxicity responses and sediment quality values found at individual stations in Ward Cove. A weight-of-evidence approach requires multiple lines of evidence for identifying stations at which unacceptable ecological risks are posed. This approach is currently recommended by EPA for sediment quality assessments throughout the United States. The underlying premise of the approach is that every kind of environmental indicator has limitations and, therefore, no one indicator can be relied on alone to provide conclusive evidence of sediment toxicity.

Using the weight-of-evidence approach, the AOC was delineated based on exceedances of MCUL and WCSQV(2) values (Figure 13), rather than SQS and WCSQV(1) values, because the former values provide a greater degree of confidence that ecological risks were present. In this manner, it was ensured that the evaluation of remedial options and any future remediation costs will be focused on those parts of Ward Cove that pose the greatest ecological risk. As part of the delineation process, stations were grouped into two categories based on whether or not they were considered an AOC station. The criteria used to designate stations were as follows:

- **AOC Stations**: Stations considered part of the AOC were those that had one or both of the following attributes:

- The MCUL values were exceeded for both the amphipod test using R. abronius and the echinoderm embryo test based on normal survival (note: no exceedances were observed for the other two sediment toxicity tests)

- The MCUL value for one toxicity test was exceeded and the WCSQV(2) value for one or more CoPCs was exceeded.

Based on those criteria, 23 stations were designated as being part of the AOC located offshore and downcurrent from the former KPC facility.

Although one additional station met the criteria for being part of the AOC, it was not included in the AOC because it was located off the fish cannery and the localized exceedances at that station were not considered to be related to the former KPC facility.

- **Non-AOC Stations**: Stations excluded from the AOC were those that had one of the following attributes:

  - No chemical or biological indicator exceeded its MCUL or WCSQV(2) value. Based on this criterion, 10 stations were designated as not being part of the AOC.

  - A single exceedance of the MCUL for a toxicity test or CoPC was found, but no other exceedances of sediment quality values for any of the other chemical or biological indicators were found that would corroborate the results of the single MCUL exceedance. Based on this criterion, 10 farfield stations were designated as not being part of the AOC **5**.

Sediments at stations that were excluded from the AOC do not pose a risk to the benthic community that warrants consideration of sediment remediation.

Based on the criteria described above, one spatially contiguous AOC of approximately 87 acres was identified (Figure 14). However, after the RI/FS was completed, remedial design investigations were conducted in 1999 to further delineate the nearshore boundary of the AOC, as well as document the nature of the Cove bottom within different areas of the AOC. Based on those investigations, approximately 7 acres along the northern shoreline of Ward Cove were eliminated from the AOC because of a lack of sediment in this area (i.e., exposed rock is predominant and no sediments are present), reducing the size of the AOC to approximately 80 acres (Figure 15).

For the Marine OU, the Selected Remedy will be performed within the 80-acre AOC (Figure 16).

5 In response to community interest, further details were provided by EPA in Response to Comment 44 (U. S. EPA 1999a).

9. DESCRIPTION OF ALTERNATIVES

This section summarizes the areas and volumes of sediments within the AOC where remediation may be warranted, and the remedial action alternatives that were developed in the RI/FS for detailed analysis.

9.1 Estimated Remediation Areas and Volumes

Based on results of the RI/FS, sediment contamination in certain portions of Ward Cove poses a risk to bottom-dwelling animals (i.e., the benthic community) living in the surface sediments. Sediment toxicity is believed to be from substances that are generated in place as a result of degradation of organic matter in the soft sediments. These substances are believed to be sulfide, ammonia, and 4-methylphenol.

The AOC represents an area and/or volume of sediment within the Marine OU where remediation may be warranted for protection of the benthic community. In the RI/FS, the boundaries of the AOC were delineated using a weight-of-evidence approach recommended by EPA for evaluation of problem sediments, and is based on exceedances of sediment quality values at individual sampling stations. Because potential risks associated with human health and ecological food-web assessments were found to be acceptable, results of those studies were not used to delineate the AOC.

The Marine OU consists of approximately 250 acres in Ward Cove, of which approximately 80 acres have been designated as an AOC where the Selected Remedy will be implemented because sediment contamination poses a risk to benthic organisms. Of these 80 acres, areas where remediation may be impracticable include approximately 14.5 acres have slopes greater than 40 percent, approximately 13.5 acres are located at depths greater than -120 ft MLLW, and approximately 10 acres have a very-high density (>500 logs/10,000 m2) of aged sunken logs. The total volume of organic-rich sediment within the 80-acre AOC, assuming an average thickness of 6 ft, is estimated to be approximately 773,000 cy.

9.2 Common Components of Alternatives

The remedial alternatives considered in the RI/FS are discussed in detail in Section 9.4. With the exception of the “no action” alternative, each of the sediment remedial action alternatives share certain common components, which are summarized below.

Within the AOC, the environmental risks (i.e., sediment toxicity) will be addressed, where practicable, by placement of clean sandy material over problem surface sediments. Placement of clean sandy material is intended to provide suitable habitat for benthic organisms, which live in the top 4 inches of bottom surface sediments. Material will be placed as either a thin-layer cap or mound (Figure 17). Capping and mounding will amend surface sediments through complete or partial surface cover and dilution. Thus, capping and mounding will reduce surface sediment toxicity to benthic organisms, and the benthic organisms will be able to colonize at an accelerated rate in these amended sediments rather than trying to inhabit the existing toxic sediments. In general, the problem sediments that remain buried beneath the 6 to 12-inch layer of amended sediments will be too deep for animals to live in.

Thin-layer capping would be accomplished by slowly and gently distributing a thin layer (e.g., 6 to 12 in.) of clean, sandy material on top of existing problem sediments. Thin-layer capping is preferable over mounding because capping provides broader coverage (see Figure 17). Mounding would be used in areas where the problem sediments cannot support a thin-layer cap (i.e., the sediments are too soft). Mounding would be accomplished by placing clean material on the existing sediments as a series of mounds that create islands or ridges of clean material (i.e., the material would not be placed in a semi-continuous sheet on top of problem sediments, but the top of the mound would extend above the problem sediments and the bottom of the mound would be supported by native sediment or bedrock). Mounding may only be practicable in areas where the thickness of the problem sediments is less than 5 ft.

Capping/mounding is particularly suitable for the type of sediment present in Ward Cove, which has high water content and low compressive strength, and which does not contain persistent chemicals that are highly toxic or that have the potential to bioaccumulate to levels of concern in animals. It is important to understand that because human health and food-web ecological risks at this site were found to be within acceptable regulatory limits, it is not necessary for the cover material to provide complete physical isolation (e.g., through placement of a thicker cap) of the problem sediment from the marine environment.

For most alternatives, navigational dredging of contaminated sediments in the vicinity of the upland facility is considered because it supports navigational needs and it is believed that a clean sand cap or mound could not be placed in these portions of the AOC without affecting potential future navigation. In the comparison of remedial alternatives, different dredging volumes were considered based on various navigational scenarios that involved dredging different areas and different depths offshore of the main dock at the upland facility (i.e., dredging volumes were not risk-based). Also considered in the alternatives were different upland and in-water disposal options for the dredged materials. There are few potential disposal sites in Ward Cove for dredged sediment because of the geographic characteristics and limited size of the Cove. In part, the different dredging volumes were also evaluated to illustrate capacity limitations of disposal sites and the very high unit costs involved in dredging and confining Ward Cove sediments.

Natural recovery is an integral component of EPA’s national sediment management strategy, and is a critical component of the remedial alternatives evaluated for this site. The estimates of recovery provided here are regarded as the best practicable, given available data and a reasonable approach to natural recovery modeling. Natural recovery would be the selected remedy for those portions of the AOC where capping or mounding is impracticable or will not be performed (e.g., in an area with a very high density of logs). Capping or mounding is not considered practicable and will not be performed in those areas of the AOC that are too steep (currently considered to be areas with slopes greater than 40 percent), are too deep (currently considered to be areas that are greater than -120 ft MLLW), are too soft to support a cap and are too thick for mounding (currently estimated to be areas with bearing strength less than 6 psf and sediment thickness greater than 5 ft), or have a very-high density of aged sunken logs (>500 logs/10,000 m2). Except for the very-high density sunken log determination, these factors will be further evaluated in remedial design activities in Ward Cove.

Aged sunken logs will be removed only from areas proposed for dredging. Sunken logs will not be removed from other areas because they do not pose a toxic risk to human health, and based on information available to EPA, aged sunken logs do not pose a known or suspected toxic risk to the environment (U. S. EPA 1999b). Acute and chronic toxic effects to benthic organisms in sediments that are in association with sunken logs has not been documented. Thin-layer capping is not recommended for very-high density log areas because the removal of logs in the very-high density areas prior to capping is not considered cost-effective, and if the logs are not removed, it is unlikely that capping material would reach and amend the surface sediments and, therefore, would have little beneficial effect. Sunken whole logs may remain on the bottom of Ward Cove for a very long period of time, and thus, may alter the bottom substrate and cause a shift in species composition (see Section 5.2).

Long-term monitoring will be required after remediation to evaluate progress towards achieving RAOs to ensure that the selected remedy is effective and that it remains protective of the environment. Long-term effectiveness of sediment remediation will be demonstrated by a reduction in sediment toxicity and the existence of a healthy benthic community in the surface sediments. The health of the benthic community will be assessed based on comparison to communities in other relatively unimpacted sediment areas of similar habitat, and will not be assessed based on a comparison to pre-remediation, or baseline, conditions. Given the decision that sunken logs in the AOC will not be removed and thus will remain on the bottom of the Cove for a long period of time, as well as the recognition that there is alteration in substrate due to the presence of sunken logs (which will obviously affect the type of benthic community living in the very-high density log areas), EPA does not intend to require long-term monitoring of benthic communities in surface sediments within the very-high density areas of sunken logs. Further, EPA does not intend to require long-term monitoring of the benthic community in the maintenance dredging area because routine dredging will clearly have short-term impacts on the structure of the benthic community in surface sediments in that area.

All alternatives include an institutional control that requires that, at the direction of EPA, the current owner of patented tidelands shall redress damage when future post-remediation activities within the AOC materially damage the thin-layer cap or mounds. As an example, when activities, such as dredging projects, expose substantial area(s) of non-native organic-rich sediments and thus adversely affect the continued recovery of the benthic community in the sediments, the current owner will be required, at the direction of EPA, to include replacement of the cap in exposed areas. It is expected that these restrictions will have minimal impact on development activities in the Cove.

9.3 Disposal Sites

If sediments were to be dredged, they could be disposed of in various ways. The range of disposal options that were considered included upland disposal (in an appropriate landfill), disposal in a nearshore confined disposal facility (NCDF) (constructed along the shoreline), and confined aquatic disposal (CAD) (which includes placement of dredged material in a submerged, aquatic site followed by capping of the dredged material with clean material).

Upland disposal options include the KPC landfill or an approved off-site landfill. The KPC landfill is currently permitted (ADEC Solid Waste Permit No. 9713-BA0001) to receive approximately 600 cy of solid waste per month, including dredge spoils. The wet organic sediment would be off-loaded from barges, de-watered, and then transported by truck to the landfill. At the landfill, the sediment would be dumped into designated areas of the landfill.

For disposal at an approved off-site landfill, the sediment would be transported by barge to an off-loading site near a landfill with capacity to accept the sediment. The total disposal cost would be very high because of the cost of shipping by barge hundreds of miles, transporting by truck, and incurring landfill disposal fees. Use of an off-site landfill is retained as a possible option for small volumes of sediment. Potential sites are located near Roosevelt, Washington, and Arlington, Oregon.

An NCDF site is typically constructed adjacent to an upland area such that the site can be used as an extension of the upland when the site is filled with sediment. Two NCDF sites were identified in Ward Cove for consideration in the development of the sediment remedial action alternatives (Figure 18). NCDF Site 1 is located in the northern portion of the AOC near the former KPC log lift and main dock. It has a capacity of approximately 155,000 cy of dredged sediment. NCDF Site 2 is located on the eastern shoreline of Ward Cove, directly east of the main upland dock. It has a capacity of approximately 175,000 cy of dredged sediment.

CAD is the placement of dredged sediment followed by capping material in an aquatic (i.e., submerged) disposal site. One CAD site was identified in Ward Cove for inclusion in the development of the sediment remedial action alternatives (see Figure 18). CAD Site 2 is located on the eastern shoreline of Ward Cove, directly east of the main dock (note: a CAD site was not located at Site 1; only an NCDF was located at Site 1). CAD Site 2 has a capacity of approximately 80,000 cy of dredged sediment.

9.4 Description of Alternatives

In the RI/FS, potential remedial technologies were screened to identify those most appropriate for remediation of sediments within the AOC of the Marine OU. In general, the remedial technologies considered for problem sediments included leaving sediments in place to recovery naturally (termed “natural recovery”); leaving sediments in place and capping/ mounding the sediments with clean, sandy material (termed “capping/mounding”); removing sediments by dredging and disposing of the dredged materials (termed “dredging with disposal”); and treating sediments either in place or, after dredging, in an upland facility.

Of these four general technologies, treatment was not considered a practicable alternative for Ward Cove sediments (see further discussion below). Thus, the remedial options that remained after screening (i.e., capping/mounding, dredging, and natural recovery) were formulated into the six alternatives that are presented below. The alternatives are numbered to correspond with the designations in the RI/FS. The “capping” alternative discussed below refers to both capping and mounding methods.

- **Alternative A1 – No action**. Superfund requires that the “no action” alternative be included to establish a baseline for comparison among alternatives. Under this alternative, no action would occur to prevent or reduce exposure to sediment contaminants.

- **Alternative A2 – Natural recovery; monitoring**. This alternative depends on natural processes (e.g., natural sediment accumulation, mixing, chemical degradation and diffusion, benthic community succession) to achieve RAOs. Long-term monitoring to confirm recovery is an important component of this alternative.

- **Alternative B – Thin cap; dredging of 12,300 cy with upland disposal; natural recovery; monitoring**. This alternative includes thin-layer capping/mounding of approximately 40 acres; dredging of 12,300 cy from 3 to 6 acres near the main dock with upland disposal (at either the KPC landfill for Option B1 or at an approved off-site landfill for Option B2); assumed dredging depths of -50 ft MLLW at the western end of the dock and -24 ft MLLW at the eastern end of the dock; thin- layer capping/ mounding of the dredged area unless native sediments are reached; natural recovery where capping is not practicable; and long-term monitoring. Alternative B as presented here is the preferred alternative identified in the Proposed Plan for the Marine OU. This alternative has since been refined based on information developed after remedial design sampling, as described in other portions of this document.

- **Alternative C – Thin cap; dredging of 80,000 cy with CAD at Site 2; natural recovery; monitoring.** This alternative includes thin-layer capping/mounding of approximately 34 acres; dredging of 80,000 cy (up to 9 ft deep over approximately 7–8 acres) with CAD in Site 2 (located on the eastern shoreline of Ward Cove, directly east of the main dock); thin-layer capping/mounding of the dredged area unless native sediments are reached; natural recovery where capping is not practicable; and long-term monitoring. Dredging volumes are based on estimates of the maximum capacity of the disposal facility.

- **Alternative D – Thin cap; dredging of 175,000 cy with disposal in an NCDF; natural recovery; monitoring**. This alternative includes thin-layer capping of approximately 34 acres; dredging of 175,000 cy (up to 9 ft deep over approximately 12–14 acres) with disposal in an NCDF at Site 2 (located on the eastern shoreline of Ward Cove, directly east of the main dock); thin-layer capping of the dredged area unless native sediments are reached; natural recovery where capping is not practicable; and long-term monitoring. Dredging volumes are based on estimates of the maximum capacity of the disposal facility.

- **Alternative E – Thin cap; dredging of 155,000 cy with disposal in an NCDF; natural**

recovery; monitoring. This alternative includes thin-layer capping/mounding of approximately 27 acres; dredging of 155,000 cy (up to 9 ft deep over approximately 10–12 acres) with disposal in an NCDF at Site 1 (located in the northern portion of the AOC near the former KPC log lift and main dock); thin-layer capping/mounding of the dredged area unless native sediments reached; natural recovery where capping/mounding is not practicable; and long-term monitoring. Dredging volumes are based on estimates of the maximum capacity of the disposal facility.

Alternatives B through E include an institutional control. The institutional control requires that, at the direction of EPA, the current owner of patented tidelands replace the cap or mound when post-remediation activities expose substantial area(s) of non-native organic-rich sediments and thus adversely affect the continued recovery of the benthic community in the sediments. Costs for each alternative (except “no action”) are shown in Table 19 and are presented as total present worth (1999). Costs shown for the O&M category represent long-term monitoring costs and are estimated based on monitoring for 10 years after construction of the remedy. Although costs are estimated based on monitoring for 10 years after construction, it is understood that monitoring will occur for as long as determined necessary by EPA (i.e., until RAOs are achieved).

10. COMPARATIVE ANALYSIS OF ALTERNATIVES

This section evaluates the different sediment remedial action alternatives in accordance with the nine criteria from EPA’s Superfund program.

10.1 Overall Protection of Human Health and the Environment

Sediments in Ward Cove do not pose unacceptable risks to human health. Accordingly, alternatives are evaluated only on whether they protect the environment. All of the alternatives, except the “no action” alternative, would provide adequate protection of the environment by eliminating, reducing, or controlling risk through one or more of the following: capping/ mounding, removal (i.e., dredging), and natural recovery. All alternatives, except the “no action” alternative, include long-term monitoring to evaluate the effectiveness and reliability of the alternative.

The “no action” alternative is typically used as a baseline for comparison of other alternatives. Because the “no action” alternative is not considered to be protective of the environment, it was eliminated from consideration under the remaining eight criteria. Natural recovery, which relies on natural processes and requires long-term monitoring until RAOs are achieved, is not “no action”.

10.2 Compliance with Applicable or Relevant and Appropriate Requirements

All alternatives comply with federal and state ARARs (see Section 12.2 for a list of ARARs), including the Endangered Species Act.

For the alternatives that involve dredging of sediments, the dredging itself would comply with turbidity requirements (or conditions for waivers) under Alaska’s water quality standards, 18 AAC 70.020. For the alternatives that include disposal of dredged sediments, such sediments would be disposed in landfills that comply with state requirements for solid waste landfills (e.g., 18 AAC 60.300) or applicable off-site disposal requirements.

10.3 Long-Term Effectiveness and Permanence

The long-term effectiveness of remediation within the AOC in the Marine OU will be measured by the existence of a healthy benthic community (e.g., worms and clams) in surface sediments. After problem sediments are remediated by capping/mounding, the existing benthic community will to a large extent be eliminated through burial; however, the newly placed clean, sandy material will provide suitable habitat for recolonization by benthic animals. The toxic effects from the existing problem sediments are not expected to impact the new benthic communities; given the types of contaminants at this site (i.e., non-persistent by-products from the decomposition of organic matter and wood debris) and given that there are no bioaccumulative CoCs at this site, some mixing of contaminated and newly placed sediments is not necessarily considered an unacceptable effect. Through mixing, the more elevated concentrations of non- persistent chemicals could be reduced in surface sediments to levels that are acceptable for benthic recolonization. Capping/mounding will not be effective in areas of Ward Cove where the cap/mound materials are not expected to stay in place (e.g., areas that are too steep, too deep, or too soft and thick).

Dredging is necessary near the existing main dock and the northeast corner of the Cove to maintain navigational depths to accommodate current and reasonably anticipated future use within the AOC and because it is believed that a clean sand cap or mound could not be placed these areas without affecting potential future navigation. Because different dredging volumes were based on various navigational scenarios (i.e., dredging volumes were not risk-based), and because dredged areas will be capped after dredging (unless native sediments or bedrock are reached), the degree of long-term effectiveness is similar among the different alternatives with various dredging options. With regard to the different options for disposal of dredged material (i.e., upland, NCDF, and CAD), the effectiveness of upland disposal facilities and NCDFs would be easier to inspect, monitor, and maintain than would the effectiveness of a CAD site.

All alternatives include long-term monitoring. The effectiveness and reliability of the selected alternative will be evaluated over time and will be reviewed at 5-year intervals to evaluate whether the response action remains protective of the environment.

10.4 Reduction of Toxicity, Mobility, or Volume through Treatment

None of the alternatives proposes treatment of sediment for the primary purpose of reducing toxicity, mobility, or volume. Treatment technologies were considered, but were screened out of further consideration because there are currently no effective technologies for treating this type of problem sediment in place, and removal of problem sediments from the AOC followed by upland treatment is not practicable because it would require significant material handling (e.g., dredging, dewatering, transport, treatment of sediments and water, disposal of residual sludges after treatment) and extreme cost (i.e., several hundred million dollars). Additional information is provided in Section 12.5.

10.5 Short-Term Effectiveness

Capping/mounding and navigational dredging could be completed within a one-year field effort, and RAOs are estimated to be achievable within 5 years of implementation of capping/ mounding and navigational dredging. Where natural recovery is the remedy, achievement of RAOs is estimated to take 8 to more than 20 years. The natural recovery rates will be different for different parts of the AOC (e.g., natural recovery rates may be quicker in areas closer to the mouth of Ward Creek due to higher sediment deposition rates). Capping/mounding is expected to achieve more substantial benthic recolonization over a shorter period of time, as compared to natural recovery, because clean, sandy material will be available on the surface of the sediments.

The least degree of short-term effectiveness is provided by natural recovery. Because natural recovery takes a longer period of time to achieve RAOs throughout the AOC, ecological risks to the benthic community would occur for a longer period of time. Natural recovery works over time through a combination of natural processes (e.g., sediment accumulation of clean sediments from natural sources, such as creeks; mixing; chemical degradation and diffusion; benthic community succession) and where toxic effects diminish on their own. As sediments in natural recovery areas become less toxic, benthic communities gradually inhabit the sediments. Numerical modeling of quantifiable natural recovery processes indicates that recovery of the benthic community may take 8 to more than 20 years. The lower end of this range (i.e., 8 years) is based on the estimated natural recovery rate for sulfide, which has been suggested to be the major cause of sediment toxicity in most areas of the Cove (based on specialized toxicity tests). Evaluations of the results of case studies on benthic communities in sediments and empirical documentation of natural recovery in sediments suggest that benthic communities, in organically rich environments such as Ward Cove, may recover within 10 years. In consideration of the numerical modeling results and the case study evaluations, recovery of benthic communities in Ward Cove may occur within approximately 10 years. For this reason, estimates of long-term monitoring costs were based on 10 years of monitoring. However, monitoring will occur until RAOs are achieved, as determined by EPA.

Existing benthic communities would likely be eliminated by either capping/mounding or dredging. However, both dredging and capping/mounding with clean sand will restore a sediment surface that is not toxic and is amenable to recolonization by native benthic fauna, Substantial recovery of the benthic community on both the dredged surface and the clean sand is expected to take place within 2 to 3 years. Sediment mounding, however, is expected to result in more heterogeneous conditions on the bottom than is dredging — that is, the mounds will settle and mix to some extent, and there will be areas of high organic content remaining between the mounds. Therefore, recovery throughout the entire area in which mounding is applied is likely to require more time than in the areas that are dredged. Because active cleanup would not occur in natural recovery areas, existing communities there would not be eliminated.

Dredging or capping/mounding would also impact water quality (e.g., through the resuspension of clean or problem sediments). These impacts can be minimized by using available construction techniques and monitoring to contain to the extent practicable the resuspension of contaminants. In-water regulatory restrictions based on fish protection (e.g., “fish windows”) would also need to be considered, and dredging or capping/mounding may temporarily disrupt water-dependent uses (e.g., vessel traffic). The potential for short- term impacts to water quality increases with the volume of sediments to be dredged.

Overall, capping/mounding has the greatest degree of short-term effectiveness.

None of the remedial alternatives is expected to adversely affect either remediation workers or the public.

10.6 Implementability

All of the remedial alternatives considered are implementable and have been used at other sites. However, there are uncertainties associated with implementing these alternatives at this site. The natural recovery and capping/mounding alternatives are the most easily implemented. Alternatives that involve extensive dredging are the most difficult to implement because of the high water content and very soft, fine-grained nature of the site sediments.

For capping/mounding activities, supplemental remedial design sampling and data evaluation would be necessary to better assess physical limitations to capping (e.g., sediment bearing capacity), placement methods, and limitations (e.g., areas where sediment is too soft to cap or too soft and too thick to mound). For dredging, equipment type and dewatering concerns would require further evaluation. For disposal of dredged materials, landfill capacity is very limited in the Ketchikan area and no other suitable landfills exist in southeast Alaska; therefore, some dredged material might have to be transported to Washington State for disposal. Constructing a CAD site or NCDF for dredged materials would be more difficult to implement than capping because of the high water content and very soft, fine-grained nature of the sediments. Capping the CAD would be difficult because of the low compressive strength and high water content of the sediments, and for both the CAD and NCDF, implementation would need to be coordinated with future development.

10.7 Cost

Cost estimates for the sediment remedial action alternatives considered in the RI/FS (Table 19) are expected to be accurate within a range of +50 to –30 percent. Current estimates indicate that the natural recovery alternative is least costly, and thin capping/mounding combined with dredging and nearshore confined disposal of dredged material is the most costly. Refinements to the preferred alternative made subsequent to the RI/FS have necessitated adjustments to the estimated cost for that alternative (see Section 11.3 for the cost estimate for the Selected Remedy).

10.8 State/Support Agency Acceptance

The State of Alaska concurs with the Selected Remedy for the Marine OU of the KPC site.

10.9 Community Acceptance

Based on comments received during the public comment period on the Proposed Plan, the there appears to be general support from the local community for the Preferred Alternative (and now the Selected Remedy). Comments received and EPA's responses to comments on the Proposed Plan are included as Part 3, the Responsiveness Summary of this ROD.

11. SELECTED REMEDY

The Selected Remedy for the Marine Operable Unit was initially described in the *Proposed Plan for the Marine Operable Unit "Ward Cove Sediment Remediation Project* (U. S. EPA 1999b). As a result of comments received on the Proposed Plan and the results of remedial design sampling in September–October 1999, refinements were made to the Selected Remedy. The Selected Remedy represents Alternative B plus refinements. The Selected Remedy applies to the Marine OU of the KPC site, and it will be performed within the 80-acre AOC.

11.1 Summary of the Rationale for the Selected Remedy

The Selected Remedy represents the best balance of tradeoffs under the nine Superfund evaluation criteria. Because the problem sediments in Ward Cove do not pose unacceptable risks to human health or to wildlife (birds and mammals) through bioaccumulation of chemicals from the sediments, the key concern is how well the Selected Remedy addresses toxic risks to benthic communities living in the sediments.

Removal of all problem sediments within the AOC in Ward Cove was considered but rejected early in EPA's evaluation. There is a large volume of problem sediments in Ward Cove but they are of relatively low toxicity. Disposal of all problem sediments would be impractical given the few disposal options. The cost would be several hundred million dollars. Because there are other reasonable alternatives that address the risk posed by the sediments, removal of all problem sediments is not reasonable, practicable, or cost-effective.

Placement of a thin-layer cap, or dredging of problem sediments followed by capping, provides suitable habitat for benthic communities. A thin-layer cap, however, is much less expensive and poses far fewer implementation difficulties than dredging and the associated disposal of hundreds of thousands of cubic yards of sediments. At this site, EPA believes that dredging is only necessary and cost-effective in areas where navigational depths must be maintained as needed for maritime use of the Cove. In dredged areas, placing a thin-layer cap after dredging unless bedrock or native sediments are reached) will provide habitat for benthic communities.

In areas where placement of a thin cap or mounding is impracticable or cannot be performed (e.g., areas that are too steep or too deep to retain a capping material), reliance on natural recovery is reasonable. EPA expects that such areas will become suitable habitat for benthic communities through natural processes of decay of toxic materials and natural accumulation of clean sediments. The tradeoff is that these natural processes are estimated to take 8 to more than 20 years to provide recovery of healthy benthic communities.

The Selected Remedy is particularly, suitable for the type of problem sediment present in Ward Cove, which has limited toxicity and does not contain persistent chemicals that are highly toxic or that have the potential to bioaccumulate. The applicability of thin capping and mounding is limited by physical constraints within Ward Cove (e.g., steep slopes along portions of the shoreline) and by the physical properties of Ward Cove problem sediments (e.g., where the soft, organic-rich sediment layer is greater than 5 feet thick and has a bearing capacity less than 6 psf).

Sunken logs will be removed only in areas where navigational dredging is performed. Sunken logs in and of themselves are not toxic and do not pose a threat to human health or the environment (U.S. EPA 1999b). EPA did not find a correlation between areas with a high density of sunken logs and sediment toxicity in Ward Cove (U.S. EPA 1999b). For these reasons, and because the logs are not located in nearshore or intertidal habitat that is important as juvenile fish habitat or feeding areas, EPA concludes that removal of sunken logs from very high-density areas – estimated to cost more than $ 1 million – is neither practicable nor cost-effective. Additionally, thin- layer capping is not recommended for very-high density log areas because log removal prior to capping is not cost-effective, and if the logs are not removed, it is unlikely that capping material would reach and amend the surface sediments and therefore, would have little beneficial effect. Given the decision that the logs will not be removed and thus will remain on the bottom of the Cove for a long period of time, as well as the recognition that there is alteration in substrate due to the presence of sunken logs (which will obviously affect the type of benthic community living in the very-high density log areas), EPA does not intend to require long-term monitoring of surface sediments in the very- high density log areas.

EPA does not intend to restrict vessel access or restrict anchoring of vessels in the Marine Operable Unit. Those types of restrictions are not necessary because the sediment cap and mounds are not intended to physically isolate problem sediments from the marine environment – the purpose of the cap and mounds is to simply provide new substrate for benthic organisms to inhabit. As an example, if vessels occasionally “dragged bottom” or dropped anchors into the sediment cap or mounds, then there may be some resuspension of problem sediments into the water column. However, the occasional resuspension of problem sediments is not a concern because the types of contaminants present in the sediments (e.g., ammonia, sulfide, 4-methylphenol) are short-lived and would quickly be dispersed in the water column and biodegraded to levels that are not considered toxic to marine organisms. Further, through mixing, the more elevated concentrations of non-persistent chemicals could be reduced in surface sediments to levels that are acceptable for benthic recolonization. As shown in the RI/FS, none of the contaminants in the sediments were found to pose unacceptable risk to either humans or wildlife through bioaccumulation.

Based on information currently available, EPA and ADEC believe that the Selected Remedy provides the best balance of tradeoffs among the alternatives with respect to the evaluation criteria.

11.2 Description of the Selected Remedy

The Selected Remedy for the Marine Operable Unit of the KPC site includes the following elements:

- The Selected Remedy will be performed within the AOC of the Marine OU because surface sediment contamination poses a risk to benthic organisms. The AOC is approximately 80 acres.

- The Selected Remedy will achieve RAOs (i.e., reduce toxicity in surface sediments and enhance recolonization of sediments to support a healthy benthic community) through a combination of thin-layer capping, mounding, navigational dredging, and natural recovery.

- Thin-layer capping: A thin-layer cap (approximately 6-to 12-inches) of clean, sandy material will be placed over problem sediments where practicable within the AOC. Thin-layer capping is preferable over mounding. Thin-layer capping is estimated to be practicable over approximately 22 acres, which includes approximately 2 acres that are predicted to be capped after dredging, 2 acres that may be either thin capped or mounded, and approximately 4 acres that are considered transition areas between the different remedial options.

- Mounding: Mounds of clean material will be placed in problem sediments where thin-layer capping is not practicable, and where mounding is practicable. Mounding will generally be considered practicable in those areas where the organic-rich sediments are less than 5 feet thick and the sediments do not have the bearing capacity to support a thin-layer sediment cap (i.e., the bearing strength is less than 6 psf). Mounding is estimated to be practicable over approximately 6 acres.

- Dredging and Upland Disposal: Navigational dredging of approximately 17,050 cy of contaminated sediments will be performed in an approximate 3-acre area in the deep draft channel berth area in front of the main dock facility. To allow reasonable access to vessels, it is estimated that this deep draft channel berth area will be dredged to approximately -41 ft MLLW at the bow end of the vessel, and to -44 ft MLLW at the stem end of the vessel. Additionally, dredging of approximately 3,500 cy of contaminated sediments will be performed in an approximate 1-acre area near the planned shallow draft barge berth area in the northeast corner of Ward Cove. To allow reasonable access to log barges, it is estimated that this shallow draft area will be dredged to -14 ft MLLW, provided that bedrock does not extend above this elevation. In both areas, the areal extent of dredging and the dredge depths have been determined to be necessary to maintain current and accommodate reasonably anticipated future navigational needs and because a cap could not be placed in these areas without constraining current and potential future navigational needs.

  Dredged sediments will be disposed of at an upland landfill authorized to accept the material. After dredging, a thin- layer cap of clean, sandy material will be placed in dredged areas unless native sediments or bedrock is reached during dredging. Potential propellor scouring will be considered in designing the capping remedy for these areas.

  Prior to dredging, sunken logs in the area to be dredged will be removed. Logs removed from the dredged areas will be disposed in an authorized landfill unless they can be otherwise used in a manner (e.g., hog fuel) that is acceptable to the regulatory agencies.

- Natural Recovery: Natural recovery is the Selected Remedy in areas where neither capping nor mounding is practicable. Natural recovery is estimated to be the remedy for approximately 50 acres of the 80-acre AOC, as follows:

  1) an 8-acre area in the center of Ward Cove and a 2-acre area near Boring Station 8 that exhibit a very high-density of sunken logs (>500 logs/10,000 m2);

  2) a 13.5-acre area where water depth to the bottom of the Cove is greater than –120 ft MLLW and the depth of the sediment is currently considered to be too great to cap;

  3) a 14.5-acre area where slopes are estimated to be greater than 40 percent and are currently considered to be too steep for capping or mounding material to remain in place;

  4) an 11-acre area where the organic-rich sediments do not have the bearing capacity (i.e., strength is less than 6 psf) to support a sediment cap and are too thick (i.e., thickness is greater than 5 ft) to practicably allow for placement of sediment mounds; and,

5) a 0.2-acre area near the sawmill log lift where maintenance dredging generally occurs on an annual basis.

- An institutional control requires that future post-remediation activities within the AOC that materially damage the thin-layer cap or mounds be required to redress such damage, at the direction of EPA. As such, the following requirement is included in an "Environmental Protection Easement and Declaration of Restrictive Covenants" recorded on October 28, 1999:

  > "Projects or activities that materially damage the cap or mounds applied to tidelands or submerged lands shall be required, at the direction of EPA, to redress such impacts, e.g., a dredging project that may erode or displace large portions of the cap will be required to repair or replace the cap."

  The term "cap" in this requirement is inclusive of any clean material (e.g., cap or mound) placed on the bottom of Ward Cove. As an example, when activities in the AOC, such as dredging projects, expose substantial area(s) of non-native organic-rich sediments and thus adversely affect the continued recovery of the benthic community in the sediments, the current owner will be required, at the direction of EPA, to include replacement of the cap in exposed areas. This requirement is enforceable by the State of Alaska Department of Natural Resources and is binding on the current and future owners of patented tidelands in Ward Cove. This control will remain in place even after RAOs are achieved.

- Long-term monitoring of surface sediments in both capped/mounded areas and in natural recovery areas will be performed until RAOs are achieved, as determined by EPA. The long-term effectiveness of sediment remediation in the AOC in Ward Cove will be demonstrated by a reduction in sediment toxicity and the existence of a healthy benthic community in the sediments. EPA does not intend to require long-term monitoring of surface sediments within the maintenance dredging area and the very-high density areas of sunken logs.

  A Monitoring and Reporting Plan will be developed pursuant to a Superfund Consent Decree that will include specific post-remediation monitoring and data requirements to evaluate the effectiveness of the Selected Remedy within the AOC. EPA will determine the number and timing of post-remediation monitoring events, and a monitoring interval of 2 or 3 years is anticipated. EPA will require monitoring of sediment toxicity and benthic infaunal community structure to measure progress towards achieving RAOs. Sediment toxicity data will be analyzed consistent with the methods used in the RI/FS. The condition of the benthic community will be analyzed using methods that will include, but will not necessarily be limited to, comparisons to areas that are considered to be relatively unimpacted areas of similar habitat (e.g., reference areas or areas of Ward Cove outside of the AOC that are of similar habitat), as well as spatial and temporal comparisons of community structure within the AOC. Spatial and temporal evaluations of benthic community structure will be evaluated through a comparison of successive sets of post-remediation monitoring data to one another, rather than comparison of monitoring data to the pre-remediation condition. Benthic community indices will include taxa richness and abundance as well as other relevant indices. EPA will require monitoring of ammonia and 4-methylphenol in surface sediments to assist in interpretation of biological monitoring data. EPA does not intend to require bulk sediment analysis of sulfide because dissolved sulfide, the most likely candidate for causative agent, cannot be adequately characterized by bulk chemistry measurements of sulfide.

  EPA intends to evaluate the results of all monitoring data following each monitoring event to determine whether consistent and acceptable progress is being made toward achieving RAOs in surface sediments in the capped/mounded areas and in natural recovery areas. EPA will use a weight-of-evidence approach to interpret monitoring data and determine whether acceptable progress is being made towards achieving RAOs. It is anticipated that the amount and rate of recovery will vary during the period following remediation, and that different elements of the remedy (e.g., thin capping, natural recovery) will achieve RAOs over differing time periods. If adequate progress is not being made, a variety of responses may be appropriate. Possible responses include (but are not limited to) performing additional remedial actions, collecting additional data to determine the cause of the failure to recover, establishing institutional controls on activities in Ward Cove, and extending the period for completion of recovery. If further action is determined by EPA to be necessary to be protective of the environment, the appropriate type of action will be determined based on the nature and severity of the failure of recovery of the benthic community, and an analysis of alternatives. EPA's Superfund Consent Decree for this site will include the standard provisions that authorize EPA to require additional cleanup measures, if necessary, at this site.

- Subtidal investigation of sediments near the east end of the main dock, and subsequent dredging and disposal of PAH-contaminated sediments, as deemed appropriate by EPA.

The areas of each type of proposed remedial action are presented in Figures 19a and 19b.

With proper planning, the Selected Remedy could be integrated with ongoing and future development plans for Ward Cove.

11.3 Summary of the Estimated Remedy Costs

The estimated cost for the Selected Remedy is $4.4 million (Table 20). This estimate includes $400,000, reported as present worth estimates, in long- term monitoring costs.

11.4 Issues to be Addressed during the Design Phase of the Selected Remedy

Prior to implementation of the Selected Remedy, design studies will be performed to confirm remedial design and remedial construction issues, including the following:

- Best placement method for the cap and mound material (e.g., split hull barge, clamshell dredge)

- Maximum water depth for capping (currently considered to be approximately –120 ft MLLW)

- Maximum slope for capping (currently considered to be approximately 40 percent)

- Maximum thickness of existing soft sediments that can be practicably capped (e.g., to determine whether capping material will "sink" into soft-bottom sediments) (currently estimated to be less than 5 ft thick).

- Type and source of sandy material to be used for capping/ mounding. The material will be tested to ensure that it is clean. In addition, capping material will be selected and placed in such a way as to provide appropriate habitat for the marine benthic organisms natural to this area.

11.5 Expected Outcomes of the Selected Remedy

Based on the results of the human health risk assessment, bottom sediments in the Marine Operable Unit do not pose unacceptable risks to human health. Accordingly, the Selected Remedy must only be protective of the environment.

In the ecological risk assessment, it was determined that sediments in portions of Ward Cove are toxic to bottom-dwelling organisms. The toxicity of the bottom sediments to the benthic community is believed to be due to the presence of ammonia, sulfide, and 4-methylphenol in the sediments. Because these chemicals do not cause problems when they are released at naturally slow rates from the bottom sediments to the overlying water column, and because sediments pose no unacceptable risks via bioaccumulation to higher trophic level organisms in Ward Cove, the purpose of the Selected Remedy is to reduce sediment toxicity and provide suitable habitat for establishment of a healthy benthic community through the placement of a thin-layer cap or mounds, where practicable. For this site, the purpose of placing clean, sandy material over problem sediments is to provide clean material that will be available for recolonization by the benthic organisms (which generally live in the top 4 inches of bottom sediments). At some sites, thicker caps are needed to provide complete physical isolation of problem sediments from human and ecological receptors (e.g., through placement of a thicker cap that is designed to eliminate the uptake of bioaccumulative contaminants by aquatic organisms either directly from the sediments or by foraging on benthic organisms). Thicker caps may also be required at some sites to stabilize contaminated sediments in-place (e.g., to prevent resuspension and transport of contaminated sediments to other areas), or to reduce the flux of dissolved contaminants into the water column. Those three components (isolation, stabilization, reduction in chemical flux) are not remediation objectives for the Selected Remedy being implemented at this site. EPA believes that thin-layer capping and mounding, along with the other elements of the Selected Remedy, will be effective in achieving the RAOs for the AOC.

The Selected Remedy will reduce the adverse environmental impacts associated with the current sediment contamination because existing problem sediments will be capped with clean material that will provide suitable habitat for recovery of the benthic community. Establishment of habitat that supports a healthy benthic community, which serves as a food source to other organisms, will also benefit larger invertebrates and fishes in Ward Cove. This improvement adds value to the active sport fisheries in Ward Cove.

The Selected Remedy has relatively minor short-term impacts to water quality in Ward Cove because the capping phase of the remedy (i.e., the in-water work) is anticipated to be completed within a 4-month period. Because of this 4-month completion period for the in-water work, the remedy also has relatively minor short-term impacts to fisheries and other water-dependent industries.

The Selected Remedy is designed to be compatible with future economic development in the Cove. The remedy does not restrict available uses of land in Ward Cove, and does not restrict vessel access or anchoring. Although an institutional control will be established to ensure that projects or activities that damage the cap/mounded areas shall redress such damage, this institutional control does not restrict potential future development in the Cove.

The effectiveness of thin capping, mounding, and natural recovery in the AOC will be evaluated against the RAOs by periodic monitoring of sediment toxicity and benthic community succession. EPA currently expects monitoring to be conducted every 2 to 3 years. The number and locations of sampling stations, the timing of monitoring events, and a framework for evaluating monitoring data will be developed as part of the long-term monitoring plan. EPA intends to evaluate the results of all recovery indicators following each monitoring event to determine whether consistent and acceptable progress toward achieving RAOs is being made. It is anticipated that the amount and rate of recovery will vary during the period following remediation, and that different elements of the remedy (e.g., thin capping, natural recovery) will achieve RAOs over differing time periods.

12. STATUTORY DETERMINATIONS

Based on information currently available, EPA and ADEC believe that the Selected Remedy provides the best balance of tradeoffs among the alternatives with respect to the evaluation criteria. EPA expects the Selected Remedy to satisfy the statutory requirements in CERCLA Section 121(b) to: 1) be protective of human health and the environment; 2) comply with ARARs; 3) be cost-effective; and 4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. CERCLA Section 121(b) also includes a preference for treatment as a principal element of the remedy. Although treatment of the sediments. within the AOC was considered, it was not included as part of the Selected Remedy because persistent, bioaccumulative chemicals are not present at concentrations contributing to unacceptable risks, and the chemicals believed to be responsible for sediment toxicity (i.e., ammonia, sulfide, 4-methylphenol) are not amenable to cost- effective treatment (see Section 12.5). None of these contaminants are considered principal threat wastes, as that term is defined in EPA guidance.

The following sections discuss how the Selected Remedy meets the CERCLA statutory requirements.

12.1 Protection of Human Health and the Environment

A human health risk assessment was conducted to identify potential risks posed by chemicals detected in sediments or seafood (e.g., fish, shellfish, other edible marine invertebrates). Direct human contact with sediments in Ward Cove is unlikely because of the depth of water overlying the affected sediments and the cold climate. Although direct contact is unlikely, this potential exposure was evaluated in a worst-case analysis and results indicate that sediments do not pose unacceptable risks to people.

Ingestion of seafood that may contain chemicals bioaccumulated from the sediments in Ward Cove was identified as the only complete exposure pathway for humans. The chemicals that were evaluated included arsenic, cadmium, mercury, zinc, phenol, 4-methylphenol, chlorinated dioxins/furans, and PAHs. Although phenol and 4-methylphenol are not considered to be bioaccumulative compounds, they were evaluated in the risk assessment because they had EPA toxicity values (a noncancer RfD) and so were included in the interest of completeness. Potential human health risks associated with seafood consumption were evaluated using both estimated and measured chemical concentrations in seafood. For the two chemical where both measured and estimated tissue concentrations were available, estimated tissue concentrations were consistently higher than measured tissue concentrations, reflecting the conservative (environmentally protective) assumptions used in estimating tissue concentrations. Using standard human health exposure assumptions and a site-specific seafood consumption rate, the risks associated with seafood consumption were found to be within acceptable ranges. Therefore, it was concluded that sediments in Ward Cove do not pose an unacceptable risk to human health. Accordingly, the objective of the Selected Remedy is to be protective of the environment.

An ecological risk assessment was conducted to identify risks to ecological receptors, including both an assessment of sediment toxicity to bottom- dwelling organisms and a food-web assessment to estimate risks of bioaccumulative chemicals to representative birds and mammals at the top of the Ward Cove food web. Through the use of sediment toxicity tests, it was determined that sediments in portions of Ward Cove are toxic to bottom-dwelling organisms. The chemicals believed to be responsible for the observed toxicity are ammonia, sulfide, and 4-methylphenol. It is believed that the fine-grained, black organic sediments in Ward Cove that are associated with adverse environmental effects are primarily the result of accumulation of particulate matter originating in the effluent discharges from the former pulp mill.

Food-web models were used to evaluate whether bioaccumulative chemicals present in the sediments of Ward Cove pose a risk to higher trophic level organisms in the local food web. The chemicals evaluated were arsenic, cadmium, mercury, zinc, chlorinated dioxins/furans, and PAHs. Ammonia, sulfide, and 4-methylphenol are not considered bioaccumulative compounds. The results of this assessment indicated that there are no unacceptable risks to higher trophic level organisms in Ward Cove.

The Selected Remedy is expected to achieve a substantial improvement in environmental conditions in Ward Cove by 1) reducing toxicity of sediments to bottom-dwelling organisms (i.e., the benthic community) in Ward Cove; 2) enhancing recolonization of animals that live in surface sediments to support a healthy community of marine animals on the bottom of Ward Cove; and 3) providing habitat, through placement of clean sandy material on the bottom of Ward Cove, that supports a community of bottom-dwelling animals that serve as a diverse food source to larger invertebrates and fishes in Ward Cove. Implementation of the Selected Remedy can be expected to result in short-term impacts to the existing benthic community through burial, although the clean material placed on the bottom sediments will in time be recolonized by benthic organisms. Implementation of the Selected Remedy may also create some short-term risk to the environment through resuspension of sediment. However, design studies as well as practice with various placement techniques will be used to minimize any short-term impacts.

12.2 Compliance with Applicable or Relevant and Appropriate Requirements

The Selected Remedy will comply with all ARARs. The ARARs identified below are all applicable requirements for the Selected Remedy.

Federal Clean Water Act Dredge and Fill Requirements; Sections 401 and 404 (33 USC 401 et seq.; 33 USC 1251–1316; 33 USC 1413; 40 CFR 230, 231; 33 CFR 320–330) — These regulations provide requirements for the discharge of dredged or fill material to waters of the United States and are applicable to any in-water work. The evaluation required under Section 404(b)(1) is complete and is included in the Administrative Record for the Marine OU of the KPC site. The finding was that this project complies with the requirements of the 404(b)(1) guidelines. As described in the 404(b)(1) analysis, steps will be taken during construction and monitoring of the project to minimize potential impacts to the aquatic resources. Water quality monitoring will occur during construction to ensure that any impacts to water quality will be temporary in nature and minimal in overall impact. Long-term water quality impacts are not expected. EPA will observe in-water construction windows to ensure that impacts to migratory fish will be avoided or minimized.

Federal Magnuson-Stevens Fishery Conservation and Management Act (1996) (16 USC Section 1851 et seq.) — This act requires that any fishery management plan include a provision to describe and identify essential fish habitat for the fishery, describe adverse effects to that habitat from both fishing and non-fishing activities, minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat. EPA has determined that the Selected Remedy will not adversely affect essential fish habitat. No alteration to the subtidal acreage will occur as a result of this project. The proposed remediation, which includes dredging and placement of clean material on bottom sediments, may cause short-term effects to the water column (e.g., increases in suspended particulates and turbidity). However, construction operations will be carefully monitored and managed to minimize adverse short-term effects. Long-term effects are expected to be beneficial, because the clean material placed on the bottom will provide more suitable habitat for benthic communities, which serve as a food source to larger invertebrates and fishes.

Federal Fish and Wildlife Coordination Act (16 USC 661 et seq.) — Ward Cove shorelines provide potential habitat for bald eagles and other avian species, and the surface waters of Ward Cove are used as a migratory route by salmonid species that spawn in Ward Creek. This act prohibits water pollution with any substance deleterious to fish, plant life, or bird life. Criteria are established regarding site selection, navigational impacts, and habitat remediation. The act also requires that fill material on aquatic lands be stabilized to prevent washout. This requirement is applicable to in-water work. The Selected Remedy complies with this Act because it is not deleterious to fish or wildlife.

Federal Rivers and Harbors Appropriations Act (33 USC 403; 33 CFR 322) — Section 10 of this act prohibits the unauthorized obstruction or alteration of any navigable water of the United States. Section 10 is applicable to structures or in-water work (including dredging and filling). The Selected Remedy is designed so that it will not obstruct or alter navigation in Ward Cove.

Federal Endangered Species Act of 1973 (16 USC 1531 et seq., 50 CFR Part 200, 402) — This regulation is applicable to any remedial actions performed at this site because this area represents potential habitat for threatened and endangered species. Threatened and endangered species potentially occurring within the local area include the American peregrine falcon, which is listed by USFWS as an endangered species, the humpback whale, which is listed by the NMFS as a threatened species, and the Stellar sea lion, which is listed by NMFS as a threatened species. The activities associated with this remedial action comply with this regulation. NMFS and USFWS concur with EPA's determination that the activities associated with this remedial action would not likely adversely affect any listed species or designated critical habitat.

Federal Coastal Zone Management Act (16 USC 1451 et seq., 15 CFR 923) — Section 307(c)(1) of the Coastal Zone Management Act requires that federal agencies conducting or supporting activities directly affecting the coastal zone, conduct or support those activities in a manner that is consistent with approved state coastal zone management programs. EPA has reviewed the Standards of the Alaska Coastal Management Program and the Ketchikan Gateway Borough Coastal Management Program and has determined that the Selected Remedy will not adversely affect the coastal zone and is consistent, to the maximum extent practicable, with the Coastal Zone Management Act.

Alaska Water Quality Standards (18 AAC 70; see also ADEC 1991) — The turbidity standard for marine waters of the Alaska Water Quality Standards is the only ARAR identified by the State for the remedial actions in the Marine Operable Unit. The turbidity standard constitutes an ARAR for dredging and capping/island mounding. Excessive turbidity detected during monitoring of the dredging or capping/island mounding operations may trigger some refinement of those operations to reduce disturbances to the quality of the water column.

Alaska Solid Waste Management Regulations (18 AAC 60) — The Alaska solid waste management regulations address the management of solid waste disposal facilities. These regulations will be applicable to remediation of Ward Cove sediments if the sediments are determined to be a solid waste and are disposed of either in an approved on-site disposal facility or in an approved off-site solid waste disposal facility.

Requirement To Be Considered (TBC requirement) — TBC requirements are state and local ordinances, advisories, guidance documents, or other requirements that, although not ARARs, may be used in determining the appropriate extent and manner of remediation. As detailed below, the Washington State sediment management standards are considered TBC requirements for this project. However, the WCSQV are neither ARARs nor TBC requirements.

There are no promulgated federal or Alaska cleanup standards for marine sediments. For the sediment toxicity assessment, the "sediment quality values" that were used to determine which areas of Ward Cove required remediation are based on the results of sediment toxicity tests and bulk chemistry data for surface sediments, portions of the State of Washington's sediment management standards (which are the only existing promulgated sediment standards in the United States), and WCSQVs for selected chemicals using methods consistent with those used to develop the Washington State sediment management standards. Although neither Alaska nor EPA have a requirement or policy that the Washington State approach must be followed for problem sediment projects, portions of the State of Washington's sediment management standards were used for this site because they are considered environmentally protective and they have received extensive scientific and public review. Further, they have some natural applicability to the marine waters of Ward Cove because they are considered protective of Puget Sound, Washington, marine species, many of which are also found in southeast Alaska, including Ward Cove.

12.3 Cost-Effectiveness

The preferred alternative represents the best balance of tradeoffs under the nine evaluation criteria. Because the problem sediments in Ward Cove do not pose unacceptable risks to human health or to wildlife (representative birds and mammals that live at the top of the food web in Ward Cove), the key concern is how well the selected remedy addresses risks to benthic communities living in the sediments.

Removal of all problem sediments within the AOC was considered but rejected early in EPA's evaluation, because the large volume of problem sediments has relatively low toxicity, disposal would be impractical, and the cost would be several hundred million dollars. There are other reasonable alternatives that address the risk posed by the sediments, and, therefore, removal of all problem sediments is not reasonable, practicable, or cost-effective.

The Selected Remedy (capping, mounding, dredging, and natural recovery) is considered to be effective and costs far less than alternatives that incorporated disposal of dredged material in a confined aquatic disposal facility or nearshore confined disposal facility. Estimated costs for Alternative B (as presented in the Proposed Plan and as refined in the Selected Remedy) ranged from $4 to $6 million, whereas estimated costs for alternatives that incorporated CAD or NCDF ranged from $16 to $30 million.

Placement of a thin-layer cap, island mounding, or dredging and removal of problem sediments followed by thin-layer capping, provides suitable habitat for benthic communities. Use of either a thin-layer cap or island mounding is considered to be effective but costs far less and poses far fewer implementation difficulties (e.g., because sediments are very soft) than placement of a thicker cap. At this site, EPA believes that dredging of contaminated sediments is only necessary and cost-effective in areas where navigational depths must be maintained. In such areas, placing a thin-layer cap after dredging (in areas where native sediments or bedrock is not reached) will provide habitat for benthic communities.

In areas where placement of a thin cap or mounding is impracticable (e.g., areas that are too steep or too deep) or cannot be performed (e.g., sediments are too soft), reliance on natural recovery is reasonable, although it may take 8 to more than 20 years to provide recovery of healthy benthic communities.

Sunken logs will be removed only in areas where dredging is performed because they are not toxic and do not pose a threat to human health or the environment. The logs are not located in nearshore or intertidal habitat that is important as juvenile fish habitat or feeding areas and they are not likely to impact navigation. EPA concludes that removal of sunken logs from the 7-acre high-density area – estimated to cost more than $1 million – is neither practicable nor cost-effective.

12.4 Utilization of Permanent Solutions and Alternative Treatment Technologies (or Resource Recovery) to the Maximum Extent Practicable

EPA has determined that the Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at this site (see next section for an explanation why treatment is not practicable at this site). The combination of mounding, thin-layer capping, and natural recovery is expected to reduce the toxicity of the existing sediments to bottom-dwelling organisms and enhance recolonization of animals that live in surface sediments to support a healthy community of marine animals and to serve as a food source to larger invertebrates and fishes. Although natural recovery requires a longer time to achieve the same degree of community improvement as island mounding or thin-layer capping, it is the only feasible alternative in areas where capping or mounding materials would not stay in place (e.g., because of steep slopes) or where capping or mounding is infeasible because of deep water. The various dredging alternatives considered all achieve a similar degree of long-term protectiveness of the environment. With regard to disposal of dredged material, the effectiveness of upland disposal facilities and NCDFs would be easier to inspect, monitor, and maintain than would the effectiveness of a CAD site.

12.5 Preference for Treatment as a Principal Element

Treatment of problem sediments from Ward Cove to reduce the toxicity or mobility of contaminants is not considered feasible. The chemicals believed to be associated with sediment toxicity are ammonia, sulfide, and 4-methylphenol. Persistent and bioaccumulative chemicals present in the sediments were shown not to present unacceptable risks, either to humans consuming seafood from Ward Cove or to higher trophic level organisms (e.g., fish-eating birds or mammals). As stated previously, treatment was evaluated for sediment remediation but was not considered further for the following reasons: 1) available in situ treatment technologies would be difficult to implement and may not be effective on the scale required for sediments in Ward Cove; 2) costs for in situ remediation would be high and there would likely be little or no improvement in ecological conditions within Ward Cove; and 3) dredging of problem sediments followed by separation of fine wood debris from the dredged sediments would be difficult to implement (requiring significant material handling), would generate large amounts of wastewater that would require treatment, and would be extremely costly while producing little or no environmental benefit.

12.6 Five-Year Review Requirements

Because the Selected Remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that may adversely affect benthic organisms, a statutory review will be conducted within 5 years after initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

12.7 Documentation of Significant Changes from Preferred Alternative of Proposed Plan

The Proposed Plan was released for public comment in July 1999. It identified Alternative B as the Preferred Alternative for sediment remediation. Alternative B consisted of a combination of thin-layer capping and/ or mounding, navigational dredging in the vicinity of the main dock (including removal of sunken logs prior to dredging and thin-layer capping of the dredged area after dredging), disposal of dredged sediments in an upland landfill, natural recovery where capping or mounding is impracticable, long-term monitoring of capped areas, mounded areas, and natural recovery areas, and an institutional control that required that future post-remediation activities within the AOC that materially damage the thin-layer cap or mounds be required to redress such damage.

As a result of comments received on the Proposed Plan and the results of remedial design sampling in September–October 1999, EPA made the following refinements to the Selected Remedy:

- The size of the AOC was reduced from 87 acres to 80 acres because portions of the north shore subtidal area were found to be very steep and rocky, and to have no sediment accumulation.

- The portion of the AOC targeted for thin-layer capping or mounding was reduced from an estimated 40 acres to an estimated 30 acres because of the limited bearing capacity and thickness of the organic-rich layer identified during early remedial design activities. In the areas to be dredged, it is estimated that dredging will reach native sediments or bedrock in an approximate 3 acre area, and thus, that 3-acre area is not estimated to require capping or mounding.

- The portion of the AOC targeted for natural recovery was increased from an estimated 47 acres in the Proposed Plan to an estimated 50 acres in this ROD because of the limited bearing capacity and thickness of the organic-rich layer identified during early remedial design activities.

- The navigational dredging strategy was refined to incorporate the depth constraints imposed by the presence of bedrock at shallower depths than the previously proposed dredge depth and to reflect current and reasonably anticipated future navigational use of the area. The areal extent of dredged areas increased from an estimated area of 2 to 3 acres to an estimated area of 5 acres. The volume of dredged sediments increased from an estimated 12,300 cy to an estimated 20,550 cy.

- An additional 2-acre area of very-high density logs (>500 logs/10,000 m2) was identified near Boring Station 8 during remedial design activities. The Selected Remedy for this area is natural recovery.

- Two RAOs have been identified for the Selected Remedy. A third RAO that had been discussed in the Proposed Plan (i.e., "Provide a community of benthic organisms that serves as an abundant food source to larger invertebrates and fishes in Ward Cove") was determined to be duplicative of the other RAOs and thus was deleted. However, Section 8 includes language that recognizes that a benefit of achieving the RAOs at this site is that a healthy benthic infaunal community serves as a diverse food source to larger invertebrates and fishes.

- Institutional controls will remain in place even after RAOs are achieved.

13. REFERENCES

ADEC. 1991. Alaska water quality standards workbook. Alaska Department of Environmental Conservation, Juneau, AK.

ADEC. 1998. Contaminated sites remediation program, risk assessment procedures manual for Method 4.0. Draft. Alaska Department of Environmental Conservation.

ADEC and U.S. EPA. 1998. Fact sheet. Ward Cove, Ketchikan, Alaska – Water quality and 303(d) issues, 12/9/98. Alaska Department of Environmental Conservation, Anchorage, AK, and U.S. Environmental Protection Agency, Region 10, Seattle, WA.

Albers, P. H. 1995. Petroleum and individual PAH, pp. 330-355. In: Handbook of Ecotoxicology. D. J. Hoffman, B. A. Rattner, G. A. Burton, Jr., and J. Cairns, Jr (eds). Lewis Publishers, Boca Raton, FL.

ATSDR. 1989. Draft toxicological profile for polycyclic aromatic hydrocarbons. U. S. Public Health Service. Agency for Toxic Substances and Disease Registry. Atlanta, GA.

AWPCB. 1953. Report No. 7, Ward Cove survey, Ketchikan, Alaska, Oct. 1 1951, through Sept. 30, 1952. Alaska Water Pollution Control Board.

AWPCB. 1957. Ward Cove Survey, 1949 – 1957. Alaska Water Pollution Control Board.

CH2M HILL. 1995. Best management practices plan. Prepared for Ketchikan Pulp Company, Ketchikan, AK. CH2M HILL, Corvallis, OR.

Delta Toxicology. 1995. Dioxins in the Sitka environment. Focus and findings of site-specific and area studies conducted in 1990 – 1995 and preliminary interpretation of health effects. Prepared for Alaska Pulp Corporation, Sitka, AK. Delta Toxicology, Inc., Seattle, WA.

E&E. 1998. Final Ketchikan Pulp Company expanded site investigation reported. Prepared for U. S. Environmental Protection Agency, Seattle, WA. Ecology and Environment, Inc., Anchorage, AK.

Eisler, R. 1994. A review of arsenic hazards to plants and animals with emphasis on fishery and wildlife resources. Chapter 11. In: Arsenic in the Environment. Part II: Human Health and Ecosystem Effects. J. O. Nriagu (ed). John Wiley & Sons, New York, NY.

ENSR. 1995. Annual sediment monitoring report, NPDES Permit No. AK-000092-2. Prepared for Ketchikan Pulp Company, Ketchikan, AK. ENSR Consulting and Engineering.

EVS. 1992. Preliminary environmental assessment of Ward Cove. Prepared for Ketchikan Pulp Company, Ketchikan, AK EVS Consultants, Seattle, WA.

EVS. 1996. Ketchikan Pulp Company annual bioaccumulation monitoring study: data report. NPDES Permit No. AK-000092-2. Prepared for Ketchikan Pulp Company, Ketchikan, AK. EVS Environmental Consultants, Inc., Seattle, WA.

Exponent. 1999. Ward Cove sediment remediation project, detailed technical studies report. Prepared for Ketchikan Pulp Company, Ketchikan, AK. Exponent, Bellevue WA.

Exponent and Hartman. 2000. Technical memorandum on Area of Concern. Ward Cove Sediment Remediation Project, Marine Operable Unit, Ketchikan Pulp Company Site, Ketchikan, AK. Prepared for Ketchikan Pulp Company, Ketchikan, AK. Exponent, Bellevue, WA and Hartman Consulting Corporation, Bellevue, WA.

Freeman, G. 1995. Personal communication (telephone conversation with L. Yost, PTI Environmental Services, Bellevue, WA, on November 14, 1995, regarding fish consumption rates for Ward Cove). Ketchikan Pulp Company, Ketchikan, AK.

FWPCA. 1965. Effects of pulp mill wastes on receiving waters at Ward Cove, Alaska. Alaska Operations Office, Northwest Region. Federal Water Pollution Control Administration.

FWQA. 1970. Effects of pulp mill wastes on receiving waters at Ward Cove, Alaska. Federal Water Quality Administration, Alaska Operations Office, Northwest Region, Anchorage, AK.

Higgins, B., and A. Amoth. 1995. Environmental achievements and future enhancements at Ketchikan Pulp Company. Internal report by KPC and CH2M HILL.

ICF Kaiser. 1996. Toxicity and exposure concerns related to arsenic in seafood: an arsenic literature review for risk assessments. ICF Kaiser, Seattle, WA.

Jones & Stokes and Kinnetic. 1989. Ward Cove Water quality assessment. Final. EPA Contract No. 68-02-4381. Jones & Stokes Associates, Inc., Bellevue, WA, and Kinnetic Laboratories, Inc., Santa Cruz, CA.

NOAA. 1995. Alaska–southeast coast. Revillagigedo Channel, Nichols Passage and Tongass Narrows; insert for Ward Cove. 1:40,000; colored. U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, Bethesda, MD.

U. S. EPA. 1975. Water quality data during September 10–13, 1974, at Ward Cove and Tongass Narrows, Alaska. U. S. Environmental Protection Agency, Alaska Operations Office, Anchorage, AK, and Region X, Surveillance and Analysis Division, Seattle, WA.

U. S. EPA. 1989. Risk assessment guidance for Superfund. Human health evaluation manual. Interim Final. Part A. U. S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC.

U. S. EPA. 1991a. Internal memorandum from P. Cirone and C. Rushin, regarding supplemental guidance for Superfund risk assessments in Region 10, dated August 23, 1991. U. S. Environmental Protection Agency, Region 10, Seattle, WA.

U. S. EPA. 1991b. Risk assessment guidance for Superfund. Volume I: human health evaluation manual. Standard default exposure factors. Interim Final. U. S. Environmental Protection Agency, Office of Emergency and Remedial Response, Toxics Integration Branch, Washington, DC.

U. S. EPA. 1992. National study of chemical residues in fish. Volume II. EPA/823/R-92/008b. U. S. Environmental Protection Agency, Office of Science and Technology, Washington, DC.

U. S. EPA. 1993. Interim report on data and methods for assessment of 2,3,7,8-tetrachlorodibenzo-p-dioxin risks to aquatic life and associated wildlife. U. S. Environmental Protection Agency, Office of Research and Development, Washington, DC.

U. S. EPA. 1996. EPA Region 10 supplemental risk assessment guidance for Superfund. Draft. Prepared by U. S. Environmental Protection Agency Region 10, Office of Environmental Assessment, Risk Evaluation Unit.

U. S. EPA. 1997. Supplemental ecological risk assessment guidance for Superfund. EPA 910-R-97-005. U. S. Environmental Protection Agency, Region 10, Office of Environmental Assessment, Seattle, WA.

U. S. EPA. 1998. Problems associated with accuracy of EPA expanded site investigation (ESI) station locations in Ward Cove, Ketchikan, AK. Memorandum from K. Keeley, EPA Region 10 Environmental Cleanup Office, Seattle, WA, to EPA Region 10 Ketchikan Pulp Company site file, Seattle, WA. U. S. Environmental Protection Agency, Seattle, WA.

U. S. EPA. 1999b. Sunken logs at Ward Cove. Memorandum dated April 21, 1999 from Karen Keeley, ECL Project Manager, to Site File Section 7.1, Ketchikan Pulp Company, Ketchikan, AK. U. S. Environmental Protection Agency, Region 10, Seattle, WA. 8 pp.

U. S. EPA. 1999a. Response to Comments received on the Public Review Draft Detailed Technical Studies Report (DTSR) for the Ward Cove Sediment Remediation Project, Ketchikan, Alaska. April 26, 1999. U. S. Environmental Protection Agency, Region 10, Seattle, WA.

U. S. EPA. 1999c. Proposed plan for the Marine Operable Unit, Ward Cove sediment remediation project, Ketchikan Pulp Company, Ketchikan, Alaska. July 1999. U. S. Environmental Protection Agency, Region 10, Seattle, WA.

U. S. EPA. 2000. U. S. EPA Integrated Risk Information System (IRIS) web page. www.epa.gov/ngispgm3/iris. U. S. Environmental Protection Agency.

Walker, M. K., J. M. Spitsbergen, J. R. Olson, and R. E. Peterson. 1991. 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) toxicity during early life stage development of lake trout (Salvelinus namaycush). Can. J. Fish. Aquat. Sci. 48: 875-883.

Wolfe, R. 1995. Personal communication (letter and document to L. Yost, PTI Environmental Services, Bellevue, WA, dated March 13, 1995, regarding harvests of seafood and wildlife in Saxton, Alaska). State of Alaska, Department of Fish and Game, Division of Subsistence, Juneau, AK.

Wolfe, R. 1998a. Personal communication (telephone conversation with L. Yost, Exponent, Bellevue, WA, on March 16, 1998, regarding appropriate fish consumption rates for Ketchikan area). Alaska Department of Fish and Game, Division of Subsistence, Juneau, AK.

PART 3: RESPONSIVENESS SUMMARY

Introduction

This section responds to comments received on the Proposed Plan for the Marine Operable Unit of the Ketchikan Pulp Company Site, Ketchikan, AK. A total of 15 documents were received or reviewed (including comments received from several individuals during the public meeting in Ketchikan on July 29, 1999). These documents are listed in the table below; the document codes in this table are referenced in the comment summaries. See also EPA's response to comments on the Detailed Technical Studies Report (April 26, 1999).

Sources of Comments on the Proposed Plan

Document	Author(s)	Description
CC-1	Anonymous	Comment card from July 29, 1999, public meeting.
CC-2	Jack Shay, Mayor of the Ketchikan Gateway Borough	Comment card from July 29, 1999, public meeting.
TDG	KPC Technical Discussion Group	Ward Cove Sediment Remediation Project; Comments on the Proposed Plan for the Marineperable Unit. Prepared by Teresa Michelsen, Avocet consulting, for the KPC Technical Discussion Group. Letter dated September 1999.
(b) [redacted]	(b) (6) [redacted], Ward Cove, AK	Comments on the Ward Cove Sediment Remediation Plan. Undated letter.
TCS	(b) (6) [redacted], Tongass Conservation Society, Ketchikan AK	Comments to Proposed Plan for the Ward Cove Sediment Remediation Project. Letter dated September 9, 1999.
SEACC	(b) (6) [redacted], Southeast Alaska Conservation Council, Juneau, AK	Comments on Proposed Plan for Ward Cove Sediment Remediation Project. Letter dated September 9, 1999, with attachments.
KPC	Barry Hogarty, Ketchikan Pulp Company, Ketchikan, AK	Comments, Proposed Plan Ward Cove Marine Operable Unit. Letter dated September 10, 1999.
NOAA	Helen Hillman, NOAA, Seattle, WA	NOAA Comments on the Proposed Plan for the Marine Operable Unit "Ward Cove Sediment Remediation Project." Letter dated September 9, 1999.
ATSDR	Karen Larson, ATSDR, Seattle, WA	Untitled letter dated September 9, 1999
(b) [redacted]	(b) (6) [redacted], Ward Cove, AK	Comments in Support of the Proposed Plan for the Marine Unit of the Ketchikan Pulp Company Project. Letter dated July 28, 1999.
NMFS	Michael Payne, NMFS, Juneau, AK	Ward Cove Sediment Remediation Project. Letter dated August 10, 1999.
PUBMTG	Multiple; see individual comments	Transcript of the public meeting held on July 29, 1999.
KGB	(b) (6) [redacted], Ketchikan Gateway Borough	Comments Regarding the Proposed Plan for the Marine Operable Unit, Ketchikan Pulp Company, Ketchikan, Alaska. Letter dated September 10, 1999.
USDOI	Pamela Bergmann, U. S. Department of the Interior, Anchorage, AK	Untitled letter dated October 1, 1999.
JUNE	(b) (6) [redacted], Haines AK	Proposed Plan for Marine Unit of Ketchikan Pulp Company Project. Letter dated September 7, 1999.

A total of 88 comments were provided in these documents. A response to each of the comments is provided in the following section. Each response includes a paraphrased summary of the original comment, as well as a reference to the source of the comment. Several comments were made more than once. In these cases, a full response is provided to one of the comments, and is cross-referenced in the responses to the other repeated comments.

Responses to Comments

1. (CC-1-1) How long will recovery take for each of the alternatives of natural recovery, a shallow cap, and dredging?

Estimated recovery times for natural recovery alone are presented in the detailed technical studies report (DTSR) (Exponent 1999). Both dredging and capping/mounding with clean sand will restore a sediment surface that is not toxic and is amenable to recolonization by native benthic fauna. Substantial recovery of the benthic community on both the dredged surface and the clean sand is expected to take place within 2 to 3 years (see Boesch 1974, Hirsch et al. 1978, McCall 1978, and Oliver et al. 1977). Sediment mounding, however, is expected to result in more heterogeneous conditions on the bottom than is dredging – that is, the mounds will settle and mix to some extent, and there will be areas of high organic content remaining between the mounds. Therefore, recovery throughout the entire area in which mounding is applied is likely to require more time than in the areas that are dredged. Conservative (i.e., protective) modeling estimates of natural recovery times for individual chemicals range from 8 to more than 20 years, and comparison to similar sites suggests that the benthic community will recover in approximately 10 years. EPA expects to achieve substantial recovery within 2 to 3 years in some parts of the cove, with recovery periods of up to approximately 20 years in other parts of the cove.

As discussed in the ROD, the majority of sunken logs in Ward Cove will not be removed because acute and chronic toxic effects to benthic organisms in sediments that are in association with sunken logs has not been documented. In terms of the Selected Remedy, thin-layer capping is not recommended for very-high density log areas because the removal of logs in the very-high density areas prior to capping is not considered cost-effective, and if the logs are not removed, it is unlikely that capping material would reach and amend the surface sediments and therefore, would have little beneficial effect. Given the decision that the logs will not be removed and thus will remain on the bottom of the Cove for a long period of time, as well as the recognition that there is alteration in substrate due to the presence of sunken logs (which will obviously affect the type of benthic community living in the very-high density log areas), EPA does not intend to require long-term monitoring of sediment toxicity or of benthic communities in surface sediments in the very-high density log areas.

See also response to comments 87 through 89 on the DTSR (U. S. EPA 1999).

2. (TDG-1) Areas outside of Ward Cove should be evaluated by EPA's Site Assessment Program and/or ADEC for potential investigation and cleanup.

As stated in the response to comments 6, 79, and 81 on the DTSR (U. S. EPA 1999), the investigation did not extend outside of Ward Cove for several reasons:

1. Phase 1 sampling indicated that problem sediments are limited to the Cove; all stations near the mouth of the Cove were determined to have acceptable chemical concentration and no toxicity. If problem sediment had been determined to extend to the boundary of the study area during Phase 1, additional sampling beyond the mouth of the Cove would have been conducted during Phase 2.

2. Sediment data from a Tongass Narrows study indicated that problem sediments attributable to KPC were not present beyond Ward Cove. This study was conducted as part of a previous evaluation of KPC's proposed outfall relocation.

3. Evaluation of current speeds and circulation patterns indicates that existing sediments in Ward Cove will not be transported out of the Cove to any appreciable extent.

4. Field observations made of grab samples of sediment from different areas near Dawson Point and around East Island indicated that sediments did not contain wood fiber, wood chips, or bark, and that sediments generally were brown (not black) in color (U. S. EPA 1998a).

Nonetheless, EPA will consider investigating other areas if a petition for a preliminary assessment is submitted to the agency and the contents of the petition are substantiated by site-specific information. EPA has provided the appropriate paperwork to several interested parties, but no petitions have been submitted to the agency to date.

3. (TDG-2) A sediment quality value was not developed for sulfides; thus, sulfide data were not used appropriately in the delineation of the area of concern.

A sediment quality value for sulfide was not developed for several reasons. First, development of a site-specific apparent effects threshold (AET) value for sulfide was determined to be questionable because of analytical uncertainty of the sulfide concentrations measured in bulk sediments collected from Ward Cove. Specifically, for Ward Cove samples, data indicate that acid- volatile sulfide (AVS) concentrations are higher than total sulfide concentrations in 20 out of 28 stations where both analyses were performed. Because AVS is a component of total sulfide, AVS results should always be lower (not higher) than total sulfide results (see U. S. EPA 1998c). Because measurements of bulk sediment sulfide concentrations are questionable, few options exist for developing a sediment quality value. Thus, EPA’s primary reason for not developing an AET value for sulfide is based on analytical uncertainty of sulfide data, not on issues related to the “dissolved porewater sulfide concentrations” as asserted by the commenter (see next paragraph).

Additionally, AET values were not developed for total sulfide because total sulfide does not represent the bioavailable (i.e., potentially toxic) form of sulfide, which is “dissolved porewater sulfide.” There are insufficient data to develop a relationship between total sediment sulfide and dissolved porewater sulfide, and it is highly unlikely that such a relationship would be meaningful or reproducible. Dissolved sulfide concentrations in pore water are likely to vary seasonally and spatially (i.e., with depth). Toxicity tests show that sulfide is the likely causative agent for at least a portion of the sediment toxicity in Ward Cove (i.e., toxicity to amphipods). The spatial distribution of observed sediment toxicity to amphipods – and thus of likely sulfide effects – was factored into the delineation of the AOC and the selection of the remedy. Additional research on the relationship between dissolved and total sulfide is not considered warranted for this site.

Finally, even if one were to accept bulk sediment sulfide concentrations at “face value,” as was done in the original draft DTSR, there are concerns about attempts to calculate AET values for sulfide. Of the four sediment toxicity tests performed in Ward Cove, sediment toxicity was not reported at any station for two of the four toxicity tests. For the third test (an amphipod bioassay), an AET value could not be calculated because the highest bulk sediment sulfide concentration was not associated with an adverse effect in the bioassay test. Thus, a second lowest AET value could not be defined for sulfide, and examination of the site-specific data showed that it would not support an identification of a no-effects value that could be used in cleanup decisions. In summary, for this site, a single AET value for sulfide could be calculated using data from only one (echinoderm bioassay) of the four sediment toxicity tests.

In contrast to sulfide, the AET values for ammonia were developed using the bioavailable fraction of that chemical, because all ammonia in the sediment is considered to be present in the dissolved (and thus, bioavailable) form.

For additional information, see EPA’s response to comment 93 on the DTSR (U. S. EPA 1999).

4. (TDG-3) The TDG concurs that thin-layer capping is an appropriate remedy for the types of sediments and contaminants found in Ward Cove. However, thin-layer capping or island mounding can and should be used at deeper depths than is outlined in the Proposed Plan.

The actual acreages where capping or mounding will occur will be determined during the remedial design phase of this project, which will be completed after this ROD is signed. Based in part on the remedial design sampling completed in September and October 1999, the feasibility study design has been refined, with more specificity in designating the capping and mounding areas (see Section 11 of the ROD). In addition, the maximum depth where these technologies can be used successfully and cost-effectively will be determined by EPA through EPA's approval of remedial design documentation.

5. (TDG-4) Dredging depths at the KPC dock are insufficient to protect a thin cap from prop wash.

Current and reasonably anticipated future use of the upland facility by Gateway Forest Products will include operations associated with a sawmill and veneer plant, and will require access along the existing main dock to support vessels of approximately 650 ft in length, 100 ft in width, with drafts of 30 ft or less. To meet that requirement, contaminated sediments in the deep draft berth area adjacent to the existing main dock facility will be dredged to a depth of -40 to -44 ft MLLW or to bedrock, whichever occurs first. Dredging will extend out about 300 ft from the face of the dock. In the dredged areas where native sediment and/ or rock have not been exposed, thin cap placement will be performed. In addition, the planned development for a shallow draft barge berth area in the northeast comer of the Cove is estimated to require navigational depths of -14 ft MLLW based on log barges that are estimated to have drafts of approximately 12 ft. The dredging is expected to expose native sediment, or rock, and thus, is not estimated to require thin layer capping (capping will be performed if native material is not exposed). As part of remedial design, prop wash modeling will be conducted to determine the effect of various vessel types on native sediment, organic sediment, and capped/mounded areas. The effect of prop wash on these different bottom materials will be used to refine the actual boundaries and depths of the various remedial actions to minimize the potential adverse effects of prop wash on cap materials while still allowing the intended operational uses.

6. (TDG-5) Water quality monitoring during dredging should include measurement of dissolved oxygen, ammonia, and "other harmful constituents."

Water quality, monitoring during dredging will focus on measurement of turbidity, which has been identified by ADEC as the only applicable State water quality criterion. In addition, monitoring during dredging may include measurements of dissolved oxygen, ammonia, and sulfide; however, rapid mixing of disturbed sediments into the oxygenated water column is expected to make ammonia and sulfide difficult or impossible to detect. Specific requirements for monitoring that will occur during dredging will be defined in a Water Quality Monitoring Plan, to be submitted by KPC to EPA as part of the Clean Water Act Section 401 water quality requirements.

7. (TDG-6) Future use restrictions and institutional controls must be clearly identified.

See the response to comment 31 regarding institutional controls in Ward Cove proper. Institutional controls associated with the uplands site will be addressed in the ROD for the Uplands Operable Unit.

8. (TDG-7) Post-remediation monitoring should focus on the health of the benthic community.

EPA's RAOs for the cleanup are to reduce sediment toxicity and to restore healthy benthic communities in the AOC. Thus, after site remediation, EPA intends to require monitoring of the benthic community in sediments in the AOC in Ward Cove, as well performing sediment toxicity tests, which are used as surrogates for measuring toxicity to benthic communities. See also responses to comments 1 and 15.

Given the physical features and site-specific conditions of the AOC within Ward Cove, EPA does not believe that a single uniform standard for measuring the condition of the benthic community or the degree of recovery will be applicable throughout all portions of the AOC.

EPA intends to evaluate monitoring data using a weight-of-evidence approach. In part, such an approach is necessary because interpretation of benthic community measurements may be hampered by 1) difficulties in reliably detecting changes in benthic communities (e.g., changes may be due to seasonal or temporal trends, and it may be difficult to find appropriate reference stations); and 2) difficulties in reliably distinguishing the biological effects of chemical contamination from habitat differences (e.g., different communities are found in muddy sediments versus sandy sediments, different communities are found at 30 ft versus 150 ft).

9. (TDG-8) CoCs should be measured as part of post-remediation monitoring.

To assist in evaluating sediment toxicity and benthic community monitoring data, EPA intends to require measurement of sediment concentrations of ammonia and 4-methylphenol in surface sediments as part of the post-remediation monitoring plan. However, unless adequate sampling and analytical methods can be identified, EPA does not intend to require monitoring of sulfide in surface sediments because dissolved sulfide, the most likely candidate for causative agent, cannot be adequately characterized by bulk chemistry measurements of sulfide. Further, it is not practical, efficient, or ecologically relevant to monitor sulfide in pore water, given its high spatial and temporal variability (see Section 8.1 of the ROD).

10. (TDG-9) A thorough baseline monitoring study should be conducted that includes all study elements that might be included in any later monitoring study.

EPA does not intend to require baseline monitoring (i.e., monitoring performed prior to implementation of sediment remediation) of the benthic community in any area of Ward Cove. EPA believes that the phased studies conducted in 1996 and 1997 characterized current conditions in Ward Cove in sufficient detail to assess the severity and spatial extent of sediment toxicity and to predict the time scale of sediment recovery. Although EPA does not consider a large baseline monitoring study to be necessary, the agency will evaluate remedial design data and consider whether it is appropriate to conduct any additional field efforts prior to implementation of remedial actions. EPA will require post-remediation monitoring of sediment toxicity and the benthic community in such a way as to be able to identify future changes in sediment toxicity and benthic community structure and to assess the rate of sediment recovery.

See also response to comment 26.

11. (TDG-10) Sediment remediation monitoring should be conducted in conjunction with water body recovery monitoring.

EPA will take advantage of opportunities to work cooperatively with the State of Alaska to coordinate monitoring efforts. However, simultaneous sampling of water and sediment is not essential to meet the goals of either the sediment or water quality monitoring programs.

12. (TDG-11) Baseline monitoring of the benthic community should be performed in areas of Ward Cove outside of the AOC.

EPA does not intend to require baseline monitoring (i.e., monitoring performed prior to implementation of sediment remediation) of the benthic community in any area of Ward Cove.

See the responses to comments 10 and 26.

13. (TDG-12) Recovery time is likely to be longer than 10 years. Monitoring effort should be apportioned appropriately throughout the recovery period. Monitoring should continue until recovery goals have been met. Natural recovery modeling should produce realistic, rather than optimistic, estimates of recovery.

Recovery time is expected to vary at different locations throughout the AOC in Ward Cove (see response to comment 1). EPA plans to have monitoring conducted throughout the recovery period, which may be longer than 10 years in some areas, until the RAOs are achieved, as determined by EPA. See also the response to comment 30 for additional information regarding apportionment of monitoring effort and assessment of goals.

EPA believes that natural recovery modeling has resulted in realistic to conservative, rather than optimistic, estimates of recovery times. Because the model may be underestimating the TOC degradation rate (based on calibration results) and the sediment deposition rate in the inner part of Ward Cove (based on the use of Station 49 for the sediment accumulation rate estimate) and does not account for the positive feedback effects of pioneering infauna, the actual natural recovery rate is likely to be greater (i.e., shorter time period) than predicted by the model.

14. (TDG-13) Concentrations of dioxin in tissue should be monitored during recovery.

As described in the DTSR (Exponent 1999), the dioxin concentrations in fish and shellfish tissue samples measured in the 1990s (see Table 6-1 and Appendix D of the DTSR) and estimated from bulk sediment concentrations collected in 1996 (see Table 6-1 of the DTSR) represent the baseline in the Cove prior to remediation. These baseline levels showed that dioxin concentrations in fish and shellfish are currently within acceptable levels for human and ecological receptors. Because capping will reduce exposed sediments with dioxins, exposure and risks are expected to be even lower in the future. Further, there are no ongoing sources of dioxin related to KPC or the former KPC facility. Specifically, problem chemicals found in sediments in the Cove appear to be primarily due to effluent discharges from KPC, which have ceased. Moreover, the uplands RI/ FS did not identify any potential ongoing sources of dioxins to the Cove.

15. (TDG-14) The monitoring plan should include a contingency plan in case recovery goals are not met.

As part of the Superfund Consent Decree that EPA is negotiating with KPC, EPA will require development of a Monitoring and Reporting Plan. In accordance with that Plan, KPC will be required to perform long-term monitoring within the AOC, at the direction of EPA, until the Selected Remedy has achieved the RAOs outlined in the ROD. Further, the Monitoring and Reporting Plan will identify a process by which the monitoring data will be evaluated and how the need for potential further actions will considered if RAOs are not being achieved in an acceptable time frame. In evaluating whether RAOs have been achieved, the Plan is expected to rely on a weight-of-evidence evaluation rather than strict triggers for additional actions. A weight-of-evidence evaluation means that EPA will consider all information relevant to whether benthic communities at a particular location are recovering as expected, i.e., there is reduction in sediment toxicity and an improvement in the condition of the benthic community. A weight-of-evidence approach is also considered appropriate for this site because determining whether the benthic community is recovering at an acceptable rate is a more sophisticated analysis than would be captured by strict numerical trigger values, such as determining whether a thick cap has been breached.

Recovery progress will be assessed following each monitoring event, and a decision will then be made regarding the need to undertake additional, or alternate, remedial actions. Because the rate of recovery is expected to change over time, more stringent criteria for acceptable recovery will be applied during later monitoring events. For example, if Year 2 monitoring data do not meet site-specific biological criteria, there would be less concern over that information then if Year 10 monitoring data do not meet biological criteria. If further action is determined by EPA to be necessary to be protective of the environment, the appropriate type of action will be determined based on the nature and severity of the failure of recovery of the benthic community, and an analysis of alternatives. EPA's Superfund Consent Decree for this site will include the standard provisions that allow EPA to require additional cleanup measures, if necessary, at this site.

In regards to the use of the term "contingency plan", Superfund guidance typically uses that term when referring to plans that describe contingency plans for potential spills and discharges from materials handling and transportation, or to plans that specifically describe alternative treatment methods that would be used if initial treatment methods were unsuccessful (such as a contingency plan for treatment of contaminated soil or water). The use of the term "contingency plan", as generally used by Superfund, is not appropriate for this site.

See also the response to comment 30 for additional discussion of post-remediation monitoring and recovery evaluation.

16. (TDG-15) The monitoring plan should be similar to that developed for APC.

See the response to comment 30 for a discussion of monitoring data collection and evaluation.

17. (TDG-16) The proposed plan does not address the formation of a layer of oxygen-depleted water at the bottom of Ward Cove as a result of sediment oxygen demand. KPC monitoring data, modeling, and previous agency evaluations indicate that a thick layer of bottom water has very low dissolved oxygen concentrations for months at a time.

EPA does not believe that transient, seasonal oxygen depletion in bottom water, which is a function of a wide variety of processes (many of which are natural), should be used to delineate an AOC in sediments at this site. Oxygen depletion in the water column is more likely to be the result of seasonal cycles of water column stratification and productivity and decay of organisms supplemented by an ongoing discharge of oxygen-depleting substances (e.g., organic material discharged to deep water from the cannery) than to the presence of organic-rich sediments. Seasonal depletion of oxygen in the water column is not considered to be controlled by sediment conditions, nor to control sediment recovery times.

Reduction of oxygen in bottom water by organic matter in bottom sediments is limited by the rate at which oxygen-consuming substances can diffuse out of the sediment and react with oxygen in the water column, a very slow process. The aerobic degradation rate of 4-methylphenol and other CoPCs and their subsequent release into the water column from the sediment has little effect on concentrations of these compounds in the sediment (i.e., concentrations of these chemicals in sediments are not reduced over time). The only pathway for these chemicals in the water column to go back to the sediments is through sorption of these compounds to settling solids, and this pathway is limited by the low affinity of these compounds for solids (i.e., low Kow). Thus, seasonal reductions in dissolved oxygen in bottom waters are not expected to have a significant effect on predictions of sediment recovery times.

The Alaska criterion of 5.0 mg/L for dissolved oxygen applies to the water column and not to the sediments. The Alaska criterion was set using data that are considered to be protective of fish. The basis for the criterion is the Water Quality Criteria document (FWPCA 1968), which states that "In tests made to date, it has been found that 5 to 8 mg/L of dissolved oxygen is apparently sufficient for all species of fish for good growth and general well being. It is recognized that in deeper waters dissolved oxygen values are often considerably less than 5.0 mg/L." Thus, the basis for the criterion is to protect fish in the water column – studies on fish provide no information on potential effects of low dissolved oxygen in the water column on animals that live in the sediment. Studies show that benthic macrofauna have a rather high tolerance to low dissolved oxygen conditions in the water column and many species react to declining oxygen concentrations with various behaviors before they eventually die. Thus, hypoxic conditions generally affect community structure (e.g., changes in species), not actual mortality. A recent scientific review of numerous studies (Diaz and Rosenberg 1995) reported that most marine invertebrates living in sediments are not significantly affected until extremely low concentrations of dissolved oxygen are reached in the water column. For many benthic invertebrates, that dissolved concentration is less than 1.4 mg/L in the overlying water column. In stagnant or semi- stagnant areas, such as protected embayments, the dissolved oxygen concentration critical to most benthic organisms appears to be around 1.4 mL/L (about 2 mg/L). Factors that contribute to the potential for effects of low oxygen include the severity, longevity, frequency, and spatial extent of the hypoxic conditions; the temporal and spatial variability of dissolved oxygen concentrations; hydrogeographic conditions (e.g., currents); water temperature, salinity and pressure (i.e., water depth); type of bottom sediment (e.g., gravel vs. mud); and type of benthic community (Diaz and Rosenberg 1995).

The one-box model of oxygen balance in deep waters of Ward Cove described in the comments on the proposed plan prepared for the TDG (Avocet 1999) is of questionable applicability to this site. The most significant defect of the model is the rate constant for sediment oxygen demand (SOD); the value that is used is unlikely to be representative of deep water in Ward Cove. The model uses a value measured by Jones & Stokes and Kinnetic (1989) in Ward Cove. Jones & Stokes and Kinnetic (1989) measured SOD at three different locations in the Cove: off the cannery, at the mouth of Ward Creek, and off the mill. SOD was highest at the mouth of Ward Creek — more than ten times higher than off the cannery. The high SOD value from the mouth of Ward Creek was used in the Avocet (1999) model. This value is unlikely to be representative of SOD in deep water for the following reasons:

- The data of Jones & Stokes and Kinnetic (1989) show that there is a great deal of spatial heterogeneity of SOD in Ward Cove. None of their measurements were taken from – or can be considered representative of — deep water at the center of Ward Cove.

- The high SOD measured at the mouth of Ward Creek is attributable to the presence of freshly deposited organic material carried into the Cove by Ward Creek, and to the thoroughly oxygenated water introduced by the creek. The rate of decay of fresh organic matter is higher than that of older organic matter such as that at the bottom of Ward Cove. Decay rates — and thus oxygen demand — are also higher in more highly oxygenated waters.

- The model used by Avocet (1999) is designed to use an SOD value that is applicable at 20oC. SOD values measured by Jones & Stokes and Kinnetic (1989) should have been either a) adjusted to be appropriate for a temperature of 20oC and then used in conjunction with a temperature coefficient, or b) adjusted to be appropriate for the temperature of Ward Cove bottom waters (10oC). No such adjustment was done. The model’s use of an SOD value measured in shallow water in the summer (i.e., at relatively warm temperatures) to represent SOD at lower temperatures in deep water will certainly lead to an overestimation of SOD. Furthermore, the temperature at the bottom of Ward Cove is at the lower limit of the applicability of temperature coefficients such as are used in the model equation (Avocet 1999, Attachment 1, equation 1); thus, if a temperature coefficient were used to predict SOD at 10oC, the prediction is likely to be quite uncertain.

- The model does not take into account the effect of dissolved oxygen concentrations on the rate of oxygen consumption. The rate of oxygen consumption (SOD) decreases as oxygen concentration becomes lower. The failure to incorporate this effect causes the model to use unrealistically high rates of oxygen consumption and to predict unrealistically low steady-state dissolved oxygen concentrations.

In addition to using an unjustifiable SOD value, the model does not address the seasonal variability of dissolved oxygen concentrations in deep water of Ward Cove. None of the parameters modeled as controlling SOD (or water column BOD) have temporally variable values. Because the model, as implemented, cannot reproduce actual seasonal changes, it is without question not accurately representing the processes affecting dissolved oxygen in Ward Cove deep water. The amount of SOD attributable to woody debris and mill effluent solids on the bottom of Ward Cove is not expected to be seasonally variable, because the quantity of these materials does not change seasonally. Changes in the quantity of decaying organic material in the water column (specifically, settling phytoplankton and cannery discharges to deep water), however, are seasonally variable effects that are ignored by the model, yet that vary in a way corresponding with the temporal changes seen in dissolved oxygen concentrations.

Comments regarding dissolved oxygen in the water column, including potential sources, will be addressed in the State’s waterbody recovery plan. EPA and ADEC intend that the State’s waterbody recovery plan will address both point sources (e.g., log rafting operations, the cannery) and nonpoint sources (e.g., loadings from Ward Creek).

18. (TDG-17) It does not appear that any of the alternatives presented in the proposed plan will attain the state ARARs for water or sediment quality contained in the Alaska State Water Quality Standards. In particular, EPA needs to show that the following substantive water and sediment quality standards in the Alaska Water Quality Standards will be met: dissolved oxygen concentrations may not be less than 5.0 mg/L; reductions in toxic and other deleterious organic and inorganic substances; narrative criteria for toxic and other deleterious organic and inorganic substances; and narrative criteria for residues. In general, the commenter asserts, the cleanup of the site should ensure that designated beneficial uses of the water body are protected.

The focus of EPA’s sediment remediation is on restoration of healthy benthic communities in the sediments affected by releases from the KPC site (see the response to comment number 30). The Alaska water quality standards, particularly the narrative standards, were not helpful in identifying specific remediation requirements for Ward Cove sediments that would restore benthic communities. The provisions in the narrative standards that relate to sediments are very broad and refer only to preventing concentrations of toxic substances in bottom sediments. The standards themselves do not establish specific cleanup levels for the contaminants of concern in the sediments. Accordingly, water quality standards in general are not legally applicable or relevant and appropriate to the sediment remediation or in establishing sediment cleanup levels. However, as a result of performing the sediment remediation selected for the Marine OU, those areas in all of Ward Cove impacted by historical releases from the KPC facility are expected to attain the narrative Alaska water quality standard for sediment toxicity.

The only water quality standard that was identified by ADEC per 40 CFR 300.40(g)(4) as an ARAR for the sediment remediation is the turbidity standard. The turbidity standard constitutes a performance standard related to dredging and capping/mounding. Excessive turbidity detected during monitoring of the dredging or capping/mounding operations may trigger some refinement of those operations to reduce disturbances to the quality of the water column.

EPA does not intend to use either the consent decree or Superfund as a vehicle for achieving water quality standards in Ward Cove. The more appropriate mechanism for attaining water quality standards (e.g., dissolved oxygen concentrations not less than 5.0 mg/L) is through a State water body recovery plan implemented pursuant to section 303 of the Clean Water Act, 33 USC §1313. The water body recovery plan is a comprehensive document and will include all potential sources in Ward Cove, not just sources attributable to KPC, in determining how to attain water quality standards throughout Ward Cove. As a result of performing the sediment remediation selected for the Marine OU, those areas in all of Ward Cove impacted by historical releases from the KPC facility are expected to attain the Alaska water quality standard for sediment toxicity.

19. (SLENK-1) It appears that chemicals of concern are being released by the decomposition of wood. Disturbing the sediment will lead to a more rapid release of CoCs; let the materials rest and decompose at a natural rate.

The majority of the organic sediment found in Ward Cove is believed to be the result of accumulation of effluent discharges from the pulp mill while the mill was active, and not a result of the decay of logs and/or wood chips. EPA believes that a combination of capping, mounding, dredging, and natural recovery is appropriate for remediation of this site. See the response to comment 74.

20. (TCS-1) Sulfide data were not considered or interpreted appropriately.

See the response to comment 3.

21. (TCS-2) Ward Cove is not listed on the National Priorities List (NPL), the remediation project is not part of the Superfund Program, and decisions and regulations governing the remediation project are not defined as, or limited to, the authority of the Superfund Program.

It is true that Ward Cove is not listed on the NPL. The NPL is EPA's list of priority sites for long-term evaluation and response actions under the Superfund program. The cleanup of Ward Cove sediments, however, did not begin under the Superfund program. The remediation of Ward Cove was originally part of the consent decree with KPC dated September 19, 1995. The consent decree embodied a settlement between the United States and KPC for violations at the KPC facility of the Clean Water Act and the Clean Air Act. Under the terms of this settlement, KPC agreed to pay a penalty in the amount of $3.1 million. KPC also agreed to implement requirements for operating the mill (e.g., using only certified wastewater treatment operators) and to perform certain projects.

One such project was to develop and implement the Ward Cove Sediment Remediation Project. As described in the consent decree, the focus of this project was clearly on sediments, not on water quality in general. Although work plans and schedules for the sediment remediation project were set forth in the consent decree, cleanup standards or objectives were not identified. There was no requirement in the consent decree that the sediment remediation project result in the attainment of water quality standards in Ward Cove or removal of Ward Cove from the state's impaired water body CWA Section 303(d) list.

The investigation work has proceeded in accordance with the consent decree and in a manner consistent with CERCLA, otherwise known as the Superfund law. EPA intends to complete the sediment remediation project under the authority of CERCLA. The CERCLA process provides a clear framework for remediating toxic substances. Under the CERCLA process, EPA will establish specific remediation objectives for the Ward Cove sediments and require long-term monitoring to ensure that those remediation objectives are met. EPA also intends to use CERCLA to finalize institutional controls for the uplands portion of the KPC site.

Several commenters requested clarification on how Superfund authorities (CERCLA) could be used to implement remediation at a site that was not listed on the NPL. Under CERCLA, EPA is authorized to take enforcement actions or enter into enforceable agreements at NPL or non-NPL sites. EPA can enter into agreements, approved by a court, with PRPs to perform work at any site where there has been a release of hazardous substances that poses an imminent and substantial endangerment to human health and the environment. Thus, even though the KPC site and Ward Cove are not listed on the NPL, EPA can still use its CERCLA authority as the basis for cleanup agreements. If EPA (or KPC pursuant to an EPA consent decree) perform a remedial action under CERCLA, then all of the requirements of CERCLA 121 with respect to cleanup standards, including the permit exemption under CERCLA 121(e), are applicable.

One limitation relating to non-NPL sites is that EPA cannot spend Superfund money for EPA-lead remedial actions at non-NPL sites.

Consistent with the intent and purpose of the 1995 consent decree, EPA intends to focus its CERCLA cleanup authorities on the most significant threat to the environment in Ward Cove. The objective of the CERCLA cleanup will be to restore healthy benthic communities in marine sediments containing problem chemicals. The recolonization of the worms and other small animals that live in sediments will benefit Ward Cove as a whole by restoring an abundant food source to larger invertebrates and fishes in Ward Cove.

In time, the sediment remediation in Ward Cove is likely to attain the Alaska water quality standard for sediment toxicity. Once monitoring results indicate that the standard has been attained, the State would be able to remove the sediment toxicity criteria as a basis for listing Ward Cove as an impaired water body.

Ward Cove is also listed as impaired because of problems with dissolved oxygen and residue. These problems, which do not pose as significant a threat to the environment as sediment toxicity, will be addressed through development and implementation of a State water body recovery plan under the Clean Water Act.

See response to comment 17 regarding dissolved oxygen.

Finally, Ward Cove exceeds the Alaska residue standard because numerous sunken logs and woody debris or other solids are present in Ward Cove. Based on extensive studies, however, EPA concluded that the sunken logs do not appear to cause toxic effects to human health or to the marine ecosystem, and the sunken logs will not be addressed by the CERCLA cleanup. The CERCLA cleanup will address other wood-derived materials that appear to be causing toxic effects in sediments.

22. (TCS-3) Alaska water quality standards for dissolved oxygen are being violated at the bottom of Ward Cove, and actual impacts to the benthic community are likely.

See the response to comment 17.

23. (TCS-4) Benthic recolonization is an RAO of this project, and to meet this RAO, it is necessary to address oxygen depletion in the water column.

See the response to comment 17.

24. (TCS-5) The DTSR and Proposed Plan do not address oxygen depletion of bottom water and benthic community effects.

See the response to comment 17.

25. (TCS-6) Oxygen depletion in bottom waters must be evaluated, even outside of the AOC.

See the response to comment 17.

26. (TCS-7) Attainment of two of the RAOs can only be evaluated by measuring the benthic community, but no benthic data have been collected either for incorporation into the "weight of evidence" approach or for use as a baseline to evaluate the success of remediation. A baseline benthic survey should be conducted as part of the monitoring program.

After implementation of the Selected Remedy, EPA intends to evaluate the future condition of the benthic community in the AOC using methods that will include, but will not necessarily be limited to, comparison to areas that are considered to be unimpacted (e.g., reference areas or areas of Ward Cove outside of the AOC that are of similar habitat), as well as spatial and temporal comparisons of benthic community structure within the AOC. Benthic community indices will include taxa richness and abundance as well as other relevant indices. At this time, we do not believe that comparison to pre-remediation, or baseline, conditions would be meaningful to determine whether the benthic community has returned to a representative natural condition. The health of a benthic community is not generally assessed by comparison to an "adversely impacted" community rather, the health of the benthic community is typically assessed based on comparison to communities in other relatively unimpacted areas of similar habitat. In terms of estimates of the rate of recovery for the benthic community, it is likely that comparison of successive sets of post-remediation monitoring data to one another, rather than comparison of monitoring data to the pre-remediation condition, will provide estimates of the rate of recovery.

See also response to comment 8. See also response to comment 39 in U. S. EPA (1999).

27. (TCS-8) There are no data to indicate that toxic effects are not occurring beyond Dawson Point.

Toxic effects evaluated using three of the four types of toxicity tests are clearly confined to Ward Cove: no toxicity was observed at the outermost stations in the Cove. The fourth type of toxicity test (echinoderm embryo survival) identified toxic effects at the outermost stations along the northern shore of the Cove. Lower levels of echinoderm embryo toxicity were found at other stations along the northern shore and elsewhere in the outer half of the Cove, and no toxicity was observed at the outermost station along the southern shore. See the response to comment 48 for a discussion of issues regarding interpretation of the echinoderm embryo test. Toxic effects clearly diminish with distance from the former KPC mill, and it is EPA's judgment that the data indicate that toxic effects will not occur outside of Ward Cove.

See also the response to comment 2.

28. (TCS-9) Concentrations of dioxins and other bioaccumulative chemicals in tissue should be measured after 10 years as part of the monitoring program.

See the responses to comments 14 and 45.

29. (TCS-10) Recovery monitoring should be coordinated with water body recovery monitoring.

EPA sediment remediation activities in Ward Cove have been coordinated with federal and state agencies responsible for the State's waterbody recovery plan for Ward Cove. EPA believes that the remedy selected for the Marine Operable Unit, including long-term recovery monitoring, will complement activities associated with the waterbody recovery plan.

For future work, EPA agrees that results of the long- term monitoring of sediments in the Marine Operable will complement the overall water body recovery planning process. As discussed at public meetings in Ketchikan, EPA believes that in time, as a result of performing the sediment remediation selected for the Marine OU, those areas in Ward Cove impacted by historical releases from the KPC facility are expected to attain the Alaska water quality standard for sediment toxicity. After monitoring results indicate that the standard has been attained, the State would be able to remove the sediment toxicity criteria as a basis for listing Ward Cove as an impaired water body.

30. (TCS-11) Criteria for success of the Proposed Plan should be specified, and a decision tree established to guide the evaluation and selection of actions.

Post-remediation monitoring will produce the information necessary to determine if the RAOs are being met. A final determination of the number and timing of post-remediation monitoring events has not yet been made, but a monitoring interval of 2 or 3 years is anticipated. This monitoring frequency will allow recovery progress to be evaluated well before the end of the expected recovery period. Monitoring will assess sediment toxicity and the condition of the benthic community, and to assist in evaluating sediment toxicity and benthic community data, monitoring will also assess surface sediment chemical concentrations of ammonia and 4-methylphenol. The sediment toxicity data will be analyzed in a manner consistent with the methods described in the DTSR. Benthic community data will be analyzed using methods that will include, but will not necessarily be limited to, comparisons to unimpacted areas of similar habitat, as well as spatial and temporal comparisons of community structure within the AOC. EPA anticipates that both the amount and the rate of recovery will vary during the period following remediation. In particular, the rate of recovery is expected to increase with time. Furthermore, measurements of sediment toxicity, benthic taxa richness, and benthic abundance may all provide differing indications of the amount and rate of recovery. Because of the variability expected to be observed in the indicators of recovery, EPA believes that it is not feasible to anticipate, and plan for, every possible combination of recovery indicators. EPA intends to evaluate the results of all recovery indicators following each monitoring event to determine whether consistent and acceptable progress is being made towards achieving RAOs.

EPA will use a weight-of-evidence approach to interpret monitoring data and determine whether acceptable progress is being made towards achieving RAOs. If adequate progress is not being made, a variety of responses may be appropriate, depending on the type and severity of the shortfall in recovery. Possible responses include (but are not limited to) performing additional remedial actions, collecting additional data to determine the cause of the failure to recover, establishing institutional controls on activities in Ward Cove, and extending the period for completion of recovery.

31. (TCS-12) Institutional controls should be identified as soon as possible, and their anticipated effects specified.

For the Marine Operable Unit, the following requirement is already included in an “Environmental Protection Easement and Declaration of Restrictive Covenants” recorded on October 28, 1999:

> “Projects or activities that materially damage the cap or mounds applied to tidelands or submerged lands shall be required, at the direction of EPA, to redress such impacts, e. g., a dredging project that may erode or displace large portions of the cap will be required to repair or replace the cap.”

The term “cap” in this requirement is inclusive of any clean material placed on the bottom of Ward Cove (e.g., both caps and mounds). As an example, if sediments were dredged from an area within the AOC that was either capped or mounded, and non-native organic-rich sediments were exposed, then at the direction of EPA, repair or replacement of the cap or mounds would be required if recovery of the benthic community in the sediments would be adversely affected. This requirement is enforceable by the State of Alaska Department of Natural Resources and is binding on the current and future owners of patented tidelands in Ward Cove.

EPA does not intend to restrict vessel access or restrict anchoring of vessels in the Marine Operable Unit. Those types of restrictions are not necessary because the sediment cap and mounds are not intended to physically isolate problem sediments from the marine environment – the purpose of the cap and mounds is to simply provide new substrate for benthic organisms to inhabit. As an example, if vessels occasionally “dragged bottom” or dropped anchors into the sediment cap or mounds, then there may be some resuspension of problem sediments into the water column. However, the occasional resuspension of problem sediments is not a concern because the types of contaminants present in the sediments (e.g., ammonia, sulfide, 4-methylphenol) are short-lived and would quickly be dispersed in the water column and biodegraded to levels that are not considered toxic to marine organisms. As shown in the RI/FS, none of the contaminants in the sediments were found to pose unacceptable risk to either humans or wildlife through bioaccumulation.

Restrictions that may be placed on activities in the Cove as a result of the State’s waterbody recovery plan will be discussed as part of that planning process. Additional information on this topic was provided in EPA’s response to comment 9 for the RI/FS (EPA, April 26, 1999).

32. (TCS-13) Source control measures need to be included as part of the ROD.

EPA believes that the fine-grained organic sediment found in Ward Cove was primarily the result of accumulation of effluent discharges from the pulp mill while the mill was active, and not a result of the decay of logs. To reduce the potential for future deposition of logs and wood chips into the Cove, the future NPDES permit for Alaska log transfer facilities and the accompanying State of Alaska Certificate of Reasonable Assurance will impose stringent best management practices.

33. (TCS-14) Ship operations need to be limited to eliminate sediment resuspension.

See response to comment 5.

34. (TCS-15) The potential for sediment resuspension (including cap material) should be studied. Further evaluation of potential resuspension from propeller wash will be conducted as part of the remedial design.

See response to comment 5.

35. (SEACC-1) Why has EPA relied on Superfund guidance to manage the Ward Cove project, and what are the short-and long-term consequences for remediation, management, and use of Ward Cove? Remediation activities in Ward Cove must comply with the Clean Water Act.

The sediment remediation in Ward Cove is being implemented at this time under a Clean Water Act consent decree, but it is EPA's intent to implement the actual cleanup under EPA Superfund remedial authorities. The Superfund process provides a clearer framework for remediating toxic substances than the Clean Water Act. For example, under the CERCLA process, EPA will establish specific remediation objectives for the Ward Cove sediments, and will require long-term monitoring to ensure that the RAOs are achieved, as determined by EPA.

See also the response to comment 21.

36. (SEACC-2) The benthic community is a legally protected receptor, per the Alaska water quality standards. Standards for the protection of the benthic community must be met in Ward Cove.

The purpose of the sediment remediation project in the Marine Operable Unit is to reduce sediment toxicity to the benthic community, and to enhance recolonization of surface sediments to support a healthy benthic community with multiple taxonomic groups within the Area of Concern. EPA believes that the sediment remediation will achieve its objective and restore a healthy benthic community in the Area of Concern. Additional information on Alaska water quality standards is provided in the response to comment 18.

37. (SEACC-3) Because the KPC site is not listed on the National Priorities List (NPL), we conclude that the concept of legally applicable or relevant and appropriate requirements (ARARs) under the Superfund program is inapplicable to this site. Therefore, EPA must ensure that all activities in Ward Cove comply with Alaska Water Quality Standards.

EPA intends to implement the cleanup of Ward Cove under the Superfund law, otherwise known as CERCLA, 42 USC § 9601 et seq. (see the response to comment 21). Section 121 of the Superfund law is titled "Cleanup Standards." Under section 121(d) of the Superfund law, all remedial actions selected under this section shall comply with ARARs. There is no requirement in the Superfund law that specifies that remedial actions selected under section 121 can only be implemented at sites included on the NPL.

See also responses to comments 18 and 21.

38. (SEACC-4) Ongoing releases from the mill will impede remediation and natural recovery. Source control must be established.

The fine-grained organic sediment found in Ward Cove was primarily the result of accumulation of effluent discharges from the pulp mill while the mill was active, and not a result of the decay of logs and/or wood chips. The recently-issued general NPDES permit for Alaska log transfer facilities, and the accompanying State of Alaska Certificate of Reasonable Assurance, imposes stringent and comprehensive best management practices to minimize discharge of bark and other debris in Ward Cove.

See also response to comment 32.

39. (SEACC-5) How much dredging has been done in Ward Cove since June 1997? If more than $2,000,000 has been "obligated" for this action and more than 12 months have elapsed since such removal activities began, how can EPA propose to allow this type of activity to continue under this proposed plan? See 40 C.F.R. 300.415(b)(5).

Dredging in Ward Cove has been historically conducted for navigational purposes and not part of any CERCLA related activities, so 40 CFR 300.415 would not be relevant to any previous dredging activities.

40. (SEACC-6) What are the results of the natural resource damages (NRD) analysis, and is the proposed plan consistent with the NRD plan?

According to Helen Hillman, the National Oceanic and Atmospheric Administration's (NOAA's) coastal resource coordinator at the EPA Region 10 office, the natural resource trustees have not conducted a natural resource damage assessment, and there are currently no plans to conduct one. NOAA has been working with EPA to ensure that the remedy is protective, and that the remedy stops the ongoing injury and prevents future injury.

41. (KPC-1) The source of capping material should not be limited to an upland source such as a quarry.

The source of the capping material will be determined during the remedial design and remedial action and will not be limited to an upland source.

42. (KPC-2) The thin layer cap is expected to be 6-12 inches thick rather than "approximately 12 inches thick."

It is anticipated that the final capping/ mounding thickness will be 6–12 in. and will vary with the thickness and shear strength of the underlying organic sediment as well as with depth and slope. A thickness of 12 in. was used for cost estimating purposes in the DTSR.

43. (KPC-3) Additional sampling (in situ shear tests, borings, and additional sediment samples for physical property characterization), as well as a pilot study, will be conducted during remedial design.

Comment noted.

44. (KPC-4) Target dredging depths should be flexible, given the uncertainty regarding future use of the facility.

The dredging depths will be refined during the remedial design phase based on knowledge of the reasonably anticipated future site use (at the time of preparation of the remedial design) and results of testing and modeling conducted as part of the remedial design.

45. (NOAA-1) The model used to assess risk to salmon from dioxins does not use the theoretical partitioning (BSAF) value of 1.7; the model was not validated; and the model does not assess risks to juvenile or resident fish.

The maternal-egg transfer model was selected as a conservative evaluation of the potential effects of dioxins on fish receptors in Ward Cove. As indicated in the ecological evaluation, risk to fish eggs was assessed because early life stages are more sensitive than older individuals are to the effects of dioxins. Therefore, this approach is considered protective of juvenile fish and resident adults, even though the exposure routes differ for these life stages (e.g., exposure of adults of benthic fish species via consumption of benthic invertebrates). The BSAF value of 1.04 that was applied in the model is a conservative value that represents the 95 percent upper confidence limit on the mean of all BSAFs for 2,3,7,8-TCDD reported for fish. Although this BSAF value may be lower than a theoretical maximum value, its conservative nature is reflected by the fact that it is 5-to 35-fold higher than steady-state BSAF values reported for 2,3,7,8-TCDD for Lake Ontario fish species. Thus, given the conservative nature of the endpoint that was assessed (i.e., early life-stage mortality) and the BSAF that was applied, the maternal-egg transfer model results indicate that dioxin concentrations in Ward Cove sediments do not constitute a risk to fish.

46. (NOAA-2) Sediment quality values were not developed for sulfide and the sulfide data were not evaluated appropriately in the delineation of the area of concern.

See the response to comment 3.

47. (NOAA-3) Subchronic, chronic, or sublethal effects of dioxins should have been evaluated.

With respect to dioxins and furans, there is no reason to believe that the relatively low concentrations found in Ward Cove sediments would result in direct toxicity to benthic macroinvertebrates that would be expressed at the population or community levels. This conclusion is supported by results of the food-web analysis, which used chronic TRVs and found no significant risks at higher trophic levels, which are considered at greatest risk from the toxic effects of dioxins and furans.

Consistent with EPA and ADEC guidance, chronic effects of low-level exposure to dioxins and furans were addressed in the human health risk assessment through consideration of cancer risks associated with consumption of fish and shellfish containing dioxins and furans.

See also response to comment 14.

48. (NOAA-4) The weight of evidence approach should not be used at stations where the echinoderm embryo test was the only environmental indicator that identified a potential problem.

The weight-of-evidence approach used for Ward Cove is the approach recommended by national experts on sediment assessment as well as EPA’s national sediment assessment programs. Therefore, the selection of this approach for use in the Cove is not arbitrary and is consistent with the most current methods of sediment assessment.

Also, as discussed in the response to comments on the DTSR (see response to comment 44 in U. S. EPA 1999), any kind of singular adverse response by the echinoderm embryo test must be questioned, given the serious concerns that exist with the validity of the test and, in particular, with the validity of the percent survival endpoint. In contrast to the commenter’s assertion that “more than half the larvae were killed,” all that can be stated with certainty is that more than half the larvae were apparently missing at the end of the test. As discussed in the response to comments on the DTSR, recent studies using screen tubes in the toxicity test chambers indicate that incomplete recovery of larvae from the test chambers at test termination could cause mortality estimates to be erroneously inflated. Therefore, it is uncertain how many of the missing larvae were actually “killed” during the test and how many surviving larvae were simply not recovered at test termination.

In addition to questionable larval recovery, there are several other aspects of the percent normality endpoint of the echinoderm embryo test that make it a less robust tool for determining the AOC in Ward Cove. Specifically, its calculation has an unquantified error component, and it exhibits higher variability compared to responses of other kinds of sediment toxicity tests.

Furthermore, at the national level, U. S. EPA (1998b) did not select the echinoderm test (or any other larval test) for implementing its contaminated sediment strategy. Among the reasons listed for this decision were:

- There have been no round-robin studies to document that the protocol generates consistent results among different testing laboratories
- The larvae are not in direct contact with the sediment throughout the entire test period, so their exposure to sediment-associated toxicants is limited
- The test has not been field-verified with indigenous benthic macroinvertebrate communities, so its ecological relevance is unknown.

Because of the limitations of the echinoderm embryo test described above, and given information summarized in EPA's response to comment 44 on the DTSR (U. S. EPA 1999), EPA has decided that this test should not be used to singularly identify sediment problems in Ward Cove. Other reliable indicators of sediment toxicity and recovery of the benthic community will be considered.

49. (NOAA-5) Natural recovery modeling underestimated the recovery time because the model relies on a deposition rate from the mouth of the creek, where the deposition rate is probably the highest in the Cove.

The statement in this comment that the sediment deposition rate was measured at the mouth of Ward Creek is incorrect. The sediment deposition rate was measured at Station 49, which is in deep water in the outer half of the Cove, and well removed from Ward Creek. Therefore, the sediment deposition rate that was used leads the model to overestimate, rather than underestimate, the natural recovery time.

50. (NOAA-6) EPA should monitor recovery and prepare for a failure to meet the RAOs in a reasonable time.

The progress of recovery will be monitored, and the results of this monitoring will be evaluated to determine whether recovery is progressing at a rate that will meet the RAOs. EPA has not yet finalized the number and timing of the monitoring events that will be needed to allow the progress of recovery to be adequately assessed. This information will be included in the Monitoring and Reporting Plan to be developed. See the response to comment 30 for more information about evaluation of monitoring data.

51. (NOAA-7) Thin layer capping may not be technically feasible because of the high water content and low compressive strength of the sediments in Ward Cove. If thin layer capping fails, EPA should be prepared with alternatives and "no action" is not an acceptable alternative. The limited feasibility of island mounding should be explained.

As discussed in the Proposed Plan, the "no action" alternative was included only to provide a basis of comparison for the other alternatives (this is required by EPA guidance). The "no action" alternative did not include natural recovery or long-term monitoring of sediments. For all of the other remediation alternatives identified in the Proposed Plan, "natural recovery" was included as a component of the alternative. Although "natural recovery" does not include physical remediation (e.g., capping or dredging of sediments) it does require long-term monitoring of natural recovery areas to evaluate whether RAOs are being met.

Within the AOC in Ward Cove, the areas where capping and/ or mounding will be feasible are currently being refined based on ongoing remedial design sampling, testing, and evaluation. This evaluation will continue through the remedial design effort. The actual acreages proposed for capping/mounding will be determined after the completion of the remedial design, and will be refined during the initial phase of remedial action. Natural recovery is the selected remedial alternative for those areas that cannot be capped or mounded.

For further information on island mounding, see response to comment 78.

52. (NOAA-8) Thin layer capping should be carried out at more, and deeper, parts of the AOC.

See the response to comment 4.

53. (NOAA-9) Limitations may have to be placed on shipping or in- water construction. The dredging depth of 50 feet will be inadequate to protect sediments, and the cap, from prop wash. Sediment should be dredged to native material at and around the deck so that thin layer capping in that area is not necessary.

Because the thin layer capping/mounding is intended to provide habitat for benthic organisms and not as a continuous barrier over the organic sediment, some disruption by anchoring or piling placement would not harm the effectiveness of the cap. The current proposed dredging depths, and any subsequent post-dredge capping, should be adequate to prevent resuspension of sediments from propellor wash. Because of the upward slope of the native bottom rock/sediments near the dock, dredging to the proposed depths will most likely remove the organic sediment present in the dredging area adjacent to the dock. The small areas of organic sediment remaining would be capped. In addition, further evaluation of potential resuspension from prop wash will be conducted as part of the remedial design.

54. (NOAA-10) Monitoring should be conducted for 20 years and should include measurements of the benthic community.

Post-remediation monitoring will include assessments of the benthic community. The duration of monitoring will be determined by the rate of recovery. Although EPA estimated in the DTSR that monitoring will be needed for 10 years, a longer (or shorter) period may prove to be appropriate.

See also the response to comment 30.

55. (ATSDR-1) Monitoring of fish and shellfish tissue during the recovery process should be conducted to address community concerns about this exposure pathway.

Bioaccumulative chemicals (i.e., chemicals that accumulate up through the food chain) are the only CoCs with respect to fish and shellfish in Ward Cove. All chemicals detected in sediments that had an EPA-derived toxicity value, were evaluated for human health risk related to bioaccummulation into fish and shellfish. This evaluation was conducted using health- protective assumptions about potential exposures. Two chemicals in Ward Cove sediments of particular concern, based on both their toxicity and ability to bioaccumulate, are mercury and dioxins. Current concentrations of mercury in sediment are below background levels, and current dioxin concentrations in fish and shellfish are below levels of concern (see the response to comment 14). An analysis of human health risk from seafood consumption indicated that none of the chemicals in Ward Cove sediments are associated with an unacceptable risk. Because remedial actions will reduce the exposure of fish to sediment chemicals, EPA considers the likelihood of future bioaccumulative risks to be very low, and monitoring of fish and shellfish tissue therefore unnecessary.

56. (NMFS-1) “Continuous monitoring of conditions in Ward Cove” should be conducted to assess the progress of cleanup and determine if additional measures are required.

The meaning of the phrase “continuous monitoring” in the comment is not clear. EPA currently expects that monitoring will be conducted at a frequency of every 2 to 3 years during the recovery period, which is considered to be sufficient to assess the progress of recovery and to determine whether additional remedial measures will be needed. Monitoring will be performed until RAOs are achieved, as determined by EPA.

57. (PUBMTG-1; (b) (6) [redacted] What kind of institutional controls will be established, and what are the impacts of different cleanup alternatives and institutional controls on future uses of Ward Cove?

See the response to comment 31.

58. (PUBMTG-2; (b) (6) [redacted]) Will institutional controls be established in the areas of natural recovery?

EPA does not currently plan to establish any institutional controls in the area of natural recovery. No current or reasonably anticipated future activities in the Cove affect deep-water sediments or steeply sloping near-shore areas for which natural recovery is the selected remedy. Changes in usage of Ward Cove can be reviewed as part of the periodic evaluation of monitoring data.

59. (PUBMTG-3; (b) (6) [redacted]) An industrial area should have a certain limited zone of low biological value.

EPA disagrees with the comment because Ward Cove is not designated exclusively for industrial activities. Under state law, Ward Cove is supposed to be available for a variety of uses, including water supply; water recreation; and growth and propagation of fish, shellfish, other aquatic life, and wildlife. The sediment remediation is intended to contribute to the overall restoration of Ward Cove so that it remains available for all designated uses.

60. (PUBMTG-4; (b) (6) [redacted]) Concentrations of dioxin in tissue should be monitored during recovery.

See the response to comment 14.

61. (PUBMTG-5;- (b) (6) [redacted] Water quality issues should be addressed as part of the cleanup. Specifically, why doesn’t EPA’s cleanup plan for Ward Cove address all water quality impairments for both the sediments and the water column in Ward Cove? [Although not specifically stated in the transcript for the public meeting, it is believed, based on previous conversations with the commenter, that the commenter is concerned that EPA’s plan only addresses “sediment toxicity” and does not address the two other parameters (i.e., “dissolved oxygen” and “residue”) for which Ward Cove is listed as an impaired waterbody under section 303(d) of the Clean Water Act]

The cleanup of Ward Cove was originally part of the consent decree with KPC dated September 19, 1995. The consent decree embodied a settlement between the United States and KPC for violations at the KPC facility of the Clean Water Act and the Clean Air Act. Under the terms of this settlement, KPC agreed to pay a penalty in the amount of $3.1 million. KPC also agreed to implement requirements for operating the mill (e.g., using only certified wastewater treatment operators) and to perform certain projects.

One such project was to develop and implement the Ward Cove Sediment Remediation Project. As described in the consent decree, the focus of this project was clearly on sediments, not on water quality in general. Although work plans and schedules for the sediment remediation project are set forth in the consent decree, cleanup standards or objectives are not identified. There is no requirement in the consent decree that the sediment remediation project result in the attainment of water quality standards in Ward Cove or removal of Ward Cove from the state’s 303(d) list.

A significant amount of investigation work has proceeded in accordance with the consent decree. EPA intends, however, to complete the sediment cleanup project under the authority CERCLA, otherwise known as the Superfund law. The CERCLA process provides a clearer framework for remediating toxic substances than the Clean Water Act. For example, under the CERCLA process, EPA will establish specific remediation objectives for the Ward Cove sediments and will require long-term monitoring to ensure that those objectives are met. EPA also intends to use CERCLA to finalize institutional controls for the uplands portion of the site.

Consistent with the intent and purpose of the consent decree, EPA intends to focus its CERCLA cleanup authorities on the most significant threat to the environment in Ward Cove. The objective of the CERCLA cleanup will be to reduce sediment toxicity and to restore healthy benthic communities in contaminated marine surface sediments. The recolonization of the worms and other small animals that live in sediments will benefit Ward Cove as a whole by restoring an abundant food source to larger invertebrates and fishes in Ward Cove.

In time, the sediment cleanup in Ward Cove is likely to attain the Alaska water quality standard for sediment toxicity. After monitoring results indicate that the standard has been attained, the State would be able to remove the sediment toxicity criteria as a basis for listing Ward Cove as an impaired waterbody.

Ward Cove is also listed as impaired because of problems with dissolved oxygen and residue. These problems, which do not pose as significant a threat to the environment as sediment toxicity, will be addressed through development and implementation of a State waterbody recovery plan under the Clean Water Act.

When the mill was operating, dissolved oxygen was a problem in the surface layer of Ward Cove. Since the closure of the KPC mill, oxygen levels in the surface layer have improved and there are no longer violations of dissolved oxygen criteria in the surface layer. There are still occasions of dissolved oxygen levels that do not meet standards in deep water during late summer months. These periodic depressions of dissolved oxygen may be occurring because of other uses in the area (e.g., the Ward Cove seafood processing facility) or due to natural conditions caused by seasonal variations. The CERCLA cleanup will not address this problem because it is not clear that it is related to the release of hazardous substances from the KPC facility.

Finally, Ward Cove exceeds the Alaska residue standard because numerous sunken logs and woody debris or other solids are present in Ward Cove as a result of operations at the former KPC facility. Based on extensive studies, however, EPA concluded that the sunken logs do not appear to cause toxic effects to human health or to the marine ecosystem. Accordingly, the sunken logs will not be addressed by the CERCLA cleanup. The CERCLA cleanup will address woody debris or other solids that appear, to be causing toxic effects in sediments.

See also the responses to comments 17, 21, and 29.

62. (PUBMTG-6; (b) (6) **What will be the effect of remediation or institutional controls on future commercial (instead of industrial) redevelopment, and specifically on the placing of pilings and anchors?**

See response to comment 31.

63. (PUBMTG-7; (b) (6) **Will institutional controls include fish advisories?**

The human health risk assessment conducted as part of the DTSR was designed to assess potential risks posed by chemicals detected in sediments or seafood from Ward Cove under present conditions (i.e., if no remedial action were undertaken). The primary CoCs in the sediments of Ward Cove are ammonia, sulfide, and 4- methylphenol. These chemicals do not bioaccumulate in seafood tissue and therefore are not of concern from a human health perspective. Chemicals that do bioaccumulate in seafood tissue (e.g., dioxins/furans, mercury) are not present in Ward Cove at concentrations high enough to pose unacceptable risks to humans consuming seafood (i.e., the human health risk assessment concluded that the existing risks to humans consuming seafood from Ward Cove were within acceptable regulatory guidelines). Hence, there is currently no need for fish advisories warning residents about consumption of seafood from Ward Cove. Following remediation of Ward Cove sediments, there is every reason to believe that the concentrations of chemicals in seafood tissues should be lower than under existing conditions, and therefore fish advisories are not anticipated to be required.

64. (PUBMTG-8; (b) (6) [redacted] **The monitoring plan should focus on boundaries of the area of biological impacts.**

The monitoring plan will be designed to characterize all parts of Ward Cove within the AOC. Areas on the boundaries of the AOC are expected to recover faster than others, and therefore focusing monitoring effort on the boundary areas may lead to an erroneously early assessment of recovery.

65. (PUBMTG-9; (b) (6) [redacted] **Ward Cove is "still a real serious health problem."**

EPA's human health risk assessment determined that the contaminants of concern in Ward Cove do not pose a threat to people. The human health risk assessment used conservative assumptions and methodologies in order to carefully examine potential risks to human health. EPA's human health risk assessment is intended not to underestimate risks. As a result, EPA's methods often tend to overestimate risks. The risk assessment applied seafood consumption rates developed by the Alaska Department of Fish and Game Subsistence Division, which are representative of average rates in a predominantly native community. Application of these rates is likely to overestimate exposure for many users of Ward Cove. Further discussion of the human health risk assessment methods is provided in Section 6 of the DTSR.

Monitoring to further evaluate human health risks is unnecessary because baseline conditions do not pose a health threat, there are no ongoing sources to increase concentrations, and the remediation of sediments is expected to reduce concentrations of bioaccumulative compounds in species that spend most of their time in Ward Cove.

See also responses to comments 14, 45, and 55.

66. (KGB-1) Cleanup work should be coordinated among permitting agencies; the Ketchikan Gateway Borough would like to review the Institutional Control Implementation Plan to ensure consistency with local land use and economic development policies.

EPA will work with the appropriate agencies as part of the remediation process. The institutional control for the Marine Operable Unit is described above in the response to comment 31, and the institutional control plan (ICP) for the Uplands Operable Unit is currently being prepared by EPA and ADEC. For informational purposes, EPA and ADEC will make available a draft copy of the ICP to interested parties. When it is finalized, it will be provided to the Ketchikan Gateway Borough and made available in the Information Repositories for the KPC site.

67. (USDOI-1) Benthic diversity could be enhanced in areas where sediment will not be dredged by placing large cobbles and boulders, which could serve as islands for sessile benthic organisms that cannot become established on the existing soft sediments.

Although the suggested actions would increase habitat diversity and potentially increase the diversity of benthic macroinvertebrate communities, the results of engineering analyses suggest that the sediments do not have the bearing capacity to support large cobbles and boulders. It is likely that they would sink into the sediment and their value as unique habitats would be lost.

68. (USDOI-2) A thin-layer cap should connect the two major capping areas to provide a migration corridor for epifauna.

Although the suggested action may enhance the dispersal of a limited number of species, the results of engineering analyses suggest that capping in the suggested area has a low probability of success and that the costs would likely outweigh the benefits for the relatively small numbers of species that might be affected.

69. (USDOI-3) Monitoring should be conducted for 20 years, and additional remedial options should be considered if recovery is not proceeding as expected.

See the responses to comments 30 and 54.

70. (USDOI-4) U. S. DOI understands that sunken logs are not considered a hazardous waste under Superfund, but we support log removal to establish a more natural habitat.

EPA has determined that the majority of sunken aged logs on the bottom of Ward Cove will not be removed under the sediment remediation project in Ward Cove because sunken logs do not pose a toxic risk to human health and the environment.

71. (JUNE-1) The proposed plan focuses on maintaining the commercial value of the KPC mill site rather than on improving the health of Ward Cove. Navigational dredging is allowed, but not remedial dredging of toxic sediment.

The option of complete dredging of the organic sediment layer was eliminated because of technological limitations, such as the impracticability of dredging at depths greater than 100 ft, and because of unreasonably high costs (estimated to be hundreds of millions of dollars) associated with complete dredging. Complete removal of the organic sediment layer is not necessary because other alternatives exist that are considered protective of the environment (particularly the benthic community). Only the upper 10 cm of the organic sediment layer is associated with the toxic effects to the benthic community, and this layer can be effectively addressed by capping/mounding; therefore, the proposed alternative of a combination of capping/ mounding, navigational dredging, and natural recovery will achieve the RAOs for the Marine Operable Unit.

72. (JUNE-2) Toxic industrial waste is misleadingly characterized as “rich organic matter.”

The releases from the pulp mill were not “toxic” as the term is commonly understood today. Within the Marine Operable Unit, the sediments that are impacted by historical KPC effluent discharges of partially degraded wood (i.e., pulping by-product) are better characterized by the terms “organic debris” or “partially degraded wood” than by the term “toxic industrial waste.” The process of wood pulping is defined as isolating and extracting the cellulose component of wood. In the process, other wood components (lignin, pitch, partially degraded organic constituents) become by-products. The primary chemicals used to extract cellulose from wood (magnesium suffite, caustic) are readily water-soluble. Historical releases from the KPC mill, in the form of pulping liquor, would have contained undegraded organic by-products (which would settle out to the sediments) and dissolved constituents (which would be dispersed in the water column). The pulping process conducted at KPC did not produce hazardous, man- made chemicals. Instead, the release of partially degraded wood by-product and the large amounts of organic matter that have accumulated in the sediments have created a condition where the natural degradation products of wood (e.g., sulfide, 4-methylphenol) are present at levels that can cause toxicity to some benthic infauna. These non- persistent, non-bioaccumulating chemicals have much more limited adverse environmental consequences than chemicals that are toxic, persistent, and bioaccumulative.

73. (JUNE-3) The alternative of complete dredging is dismissed without a complete evaluation of costs.

The option of complete dredging was considered but was eliminated because there is a very large volume of problem sediments in Ward Cove but they are of relatively low toxicity. Disposal of all problem sediments would be very difficult given the few disposal options. Using unit costs for navigational dredging, the estimated cost of complete dredging is more than $200 million. Because of uncertainties in the technology required for dredging and dewatering the organic sediment from the depths at which it is present in Ward Cove, the actual cost of complete dredging could be considerably higher than $200 million. Because there are other reasonable alternatives that address the risk posed by sediments, removal of all problem sediments is not reasonable, practicable, or cost- effective.

74. (JUNE-4) Thin layer capping is unlikely to be effective, particularly if sunken logs are not removed first.

As discussed on pages 11-15 through 11-17 of the DTSR, an evaluation of the cost-effectiveness of removing sunken logs was conducted. Log removal prior to capping/mounding would raise the cost per acre by more than 300 percent with only questionable benefits. Log removal would also likely result in resuspension of the organic-rich sediments into the water column. Because the logs themselves do not pose a toxic risk to human health or the environment and because most are located in water deep enough so as not to interfere with the intended uses of the Cove, log removal is not necessary.

75. (JUNE-5) The natural recovery alternative seems intended to limit Louisiana-Pacific's (L-P's) liability. The time for natural recovery and the final condition of the benthic community needs to be more definitive. L-P should post a performance bond of $100-$200 million to cover dredging if natural recovery fails.

EPA intends to ensure the accomplishment of the RAOs (i.e., reduction in sediment toxicity and establishment of healthy benthic communities in Ward Cove surface sediments) through a binding, court- enforceable consent decree with KPC and L-P. The consent decree will require KPC and L-P to monitor and assess whether the RAOs are being attained, including in areas designated for natural recovery. If the objectives are not attained within the anticipated time frame, EPA may require KPC and L-P to perform additional remediation activities. Accordingly, a performance bond is not necessary. EPA will require, however, that KPC and L-P provide financial assurances that it has the resources to perform all required remediation activities.

76. (CC-2) EPA's answers to questions raised during public meeting on July 29, 1999, will be helpful in the Ketchikan Gateway Borough's planning process.

Comment noted.

77. (TDG-18) The TDG is in agreement with many of the conclusions drawn by EPA as a result of the DTSR and other available studies, including:

- **There are currently no significant, long-term risks to human health or wildlife**
- **Risks to the benthic community are present and significant, due to the degradation of organic wastes deposited on the bottom by mill operations**
- **Risks to the benthic community warrant remedial action**
- **The narrative remedial action objectives are appropriate cleanup and recovery goals**
- **The proposed remedial alternative is reasonable, although the TDG would prefer that thin-layer capping be extended into deeper areas of the AOC to minimize reliance on natural recovery.**

Comment noted. See the response to comment 4 regarding the extent of sediment mounding or thin-layer capping.

78. (TDG-19) Why would island mounding be limited to a smaller area (21 acres) than thin-layer capping?

The technique of island mounding, unlike thin-layer capping, depends on the thickness of the surface layer of soft organic sediment. Island mounding is generally limited to those areas of the AOC where the organic sediment is too soft to cap and the layer is less than 5 ft thick — at greater depths an inordinately large quantity of sand is required. This limitation on the feasibility of island mounding restricts it to a smaller part of the AOC than thin capping.

The actual acreages suitable for capping or mounding are being refined based on additional sampling conducted for the remedial design.

79. ((b) -2) The plan will work in the best interest of all the true stakeholders involved. The environment, not political motivation, would be best served by the least amount of disturbance possible. Effects result not from toxic chemicals, but only from the decomposition of wood.

Comment noted.

80. (SEACC-7) KPC's NPDES permit for log rafting should be terminated.

The Natural Resources Defense Council requested that EPA terminate KPC's NPDES permit for the Ward Cove LTF. In July 1999, EPA provided a written response to that request and stated that it does not plan to terminate this NPDES permit. In March 2000, EPA issued a general NPDES permit for Alaska LTFs.

81. (KPC-5) The preferred alternative is the most appropriate alternative for remediation of the Marine Operable Unit.

Comment noted.

82. (ATSDR-2) Based on a review of supporting documents from the site, health effects from exposure to sediments or consumption of fish and shellfish from Ward Cove are not expected. It appears that the proposed plan will adequately protect public health.

Comment noted.

83. (KGB-2) The KGB supports the proposed dredging which would allow future and reasonable commercial navigation in the Cove consistent with its industrial land-use classification. The Proposed Plan appears to adequately address impacts to human health and the environment.

Comment noted.

84. ((b) -1) The preferred alternative is a reasonable and fair solution. A more expensive alternative will not provide any substantial environmental benefits for the costs incurred.

Comment noted.

85. (PUBMTG-10; (b) (6)) There is really no pollution in Ward Cove - it's just an area of waste disposal that does not support bottom life. The site should be left alone and allowed to recover naturally, but understands that the law requires some kind of action.

Comment noted.

86. (PUBMTG-11; (b) (6)) The agencies and KPC have done a good job getting the Ward Cove project done in a timely manner. Ward Cove doesn’t seem to be in very bad shape. The agencies and KPC should continue, to work with the Borough and the community to find ways to re-develop the site.

Comment noted.

87. (PUBMTG-12; (b) (6)) Information on dioxin concentrations in fish tissue indicates that dioxin is probably not, at this point, constituting a health risk to most people within the community.

Comment noted.

88. (NOAA-11) A SQV for dioxin could have been applied at KPC.

As noted in EPA’s April 15, 1998, comment letter to KPC on the draft DTSR (U. S. EPA 1998c), EPA did not believe it was appropriate to derive a site- specific AET value for dioxins at this site. Also, see Table 7-23 of the DTSR (the highest dioxin incidence is associated with no adverse effects in three of four tests).

References

Avocet. 1999. Ward Cove sediment remediation project, comments on the proposed plan for the Marine Operable Unit prepared by EPA Region 10, Seattle, WA. Prepared for KPC Technical Discussion Group, Ketchikan, AK. Avocet Consulting, Kenmore, WA.

Boesch, D. F. 1974. Diversity, stability and response to human disturbance in estuarine ecosystems. pp. 109-114. In:Proc. of the First International Congress of Ecology, Structure, Functioning and Management of Ecosystems. The Hague, Netherlands.

Diaz, R. J., and R. Rosenberg. 1995. Marine benthic hypoxia: a review of its ecological effects and the behavioral responses of benthic macrofauna. Oceanography and Marine Biology: An Annual Review 33:245–303.

Exponent. 1999. Ward Cove sediment remediation project detailed technical studies report. Volume I. Remedial investigation and feasibility study. Exponent, Bellevue, WA.

FWPCA. 1968. Water quality criteria. Report of the National Technical Advisory Committee to the Secretary of the Interior. Federal Water Pollution Control Administration, Washington, DC.

Hirsch, N. D., L. H. DiSalvo, and R. Peddicord. 1978. Effects of dredging and disposal on aquatic organisms. Rept. No. DS-78-5. U. S. Army Engineer Waterways Experiment Station Environmental Laboratory, Vicksburg, MS. 41 pp.

Jones & Stokes and Kinnetic. 1989. Ward Cove water quality assessment. Final. EPA Contract No. 68-02-4381. Jones & Stokes Associates, Inc., Bellevue, WA, and Kinnetic Laboratories, Inc., Santa Cruz, CA.

McCall, P. L. 1978. Spatial- temporal distributions of Long Island infauna: the role of bottom disturbance in a nearshore marine habitat. pp. 191-219. In: Estuarine Interactions, M. L. Wiley (ed.). Academic Press, New York, NY.

Oliver, J. S., P. N. Slattery, L. W. Hulberg, and JW. Nybakken. 1977. Patterns of succession in benthic infaunal communities following dredging and dredged material disposal in Monterey Bay. Tech. Rept. No. D-77-27. U. S. Army Engineer Waterways Experiment Station Environmental Effects Laboratory, Vicksburg, MS. 186 pp.

U. S. EPA. 1998a. EPA memorandum on September 18, 1998 Site Visit to Ward Cove, Ketchikan, Alaska. November 24, 1998. U. S. Environmental Protection Agency, Seattle, WA.

U. S. EPA. 1998b. EPA’s contaminated sediment management strategy: comment and response document. U. S. Environmental Protection Agency, Office of Water, Washington, DC.

U. S. EPA. 1998c. EPA comment letter to Ketchikan Pulp Company on draft DTSR. U. S. Environmental Protection Agency, Seattle, WA.

U. S. EPA. 1999. EPA response to public comments, Ward Cove sediment remediation project, public review draft, detailed technical study report (August 1998). April 26, 1999. U. S. Environmental Protection Agency, Seattle, WA.

Tables

TABLES

Table 1. **Summary of chemicals of concern and their respective concentrations for sediments in Ward Cove in 1996 and 1997**

	1996			1997		
Station	Total Ammonia (mg/kg)	Total Sulfide (mg/kg)	4-Methyl-phenol (Fg/kg)	Total Ammonia (mg/kg)	Total Sulfide (mg/kg)	4-Methyl-phenol (Fg/kg)
Ward Cove-Subtidal						
1	310	1,700	6,000			
2	220	1,200	11,000	85	4,500	15,000
3	14	5,300	5,600	80	500	6,200
4	97	6,500	2,900	150	3,700	4,500
5	67	5,400	860	57	2,300	16,000
6	360	2,200	8,300			
7	74	1,800	1,700	120	1,900	7,500
8	100	2,700	1,400			
9	82	4,500	1,400			
10	99	5,500	250 *U*			
11	50	1,500	200 *U*	34	2,300	380
12	260	2,700	620	240	1,900	8,300
13	150	4,300	390	320	2,700	1,700
14	130	2,200	1,000			
15	83	2,700	220			
16	81	16,000	250 *U*	40	12,000	1,200
17	11	27,000	250 *U*	99	50	570
18	13	150	20 *U*	13	310	26
19	44	800	250 *U*	110	5,500	730
20	84	420	470			
21	88	3,500	250 *U*			
22	21	380	200 *U*	19	560	24
23	14	1,200	49	86	3,900	170
24	34	670	250 *U*			
25	160	1,000	1,700	120	3,800	6,600
26	66	2,200	200 *U*			
27	43	4,300	200 *U*	47	4,500	470
28	34	2,400	200 *U*	34	4,400	802
31				510	11,000	17,000
32				82	13,000	2,700
33				23	1,600	980
34				120	2,300	5,100
35				120	3,300	460
37				54	2,700	4,400
38				260	6,700	8,300
39				110	2,700	1,300
40				80	3,800	1,000
41				58	48	640
42				82	2,000	5,700
43				110	9,700	1,000
44				690	2,300	9,000
45				170	4,800	2,400
47				120	3,000	1,800
48				300	3,900	1,100
Ward Cove-Intertidal						
50				3.2	20 *U*	10 *U*
51				11	1,000	231

Note: All concentrations reported on dry weight basis.

U - undetected at concentration listed

Table 2. Summary of conventional CoPCs for sediments in Ward Cove and Moser Bay in 1996 and comparison with sediment quality values

Station	TOC (percent)		Total Ammonia (mg/kg)		Total Sulfide (mg/kg)	BOD (g/kg)		COD (g/kg)	
Ward Cove-Subtidal									
1	32	**	310	**	1,700	16	*	480	
2	14		220	**	1,200	9.9		330	
3	22		14		5,300	7.3		250	
4	26		97		6,500	12	*	470	
5	36	**	67		5,400	10		590	*
6	33	**	360	**	2,200	13	*	540	
7	26		74		1,800	8.7		620	*
8	24		100		2,700	12	*	2,400	**
9	27		82		4,500	19	*	550	
10	27		99		5,500	9.8		340	
11	14		50		1,500	6.4		190	
12	24		260	**	2,700	10		520	
13	22		150	**	4,300	8.3		440	
14	25		130	**	2,200	16	*	190	
15	25		83		2,700	6.0		490	
16	31		81		16,000	18	*	620	*
17	31		11		27,000	7.6		150	
18	1.1		13		150	1.4		17	
19	18		44		800	9.6		270	
20	17		84		420	1.1		120	
21	21		88		3,500	6.2		420	
22	5		21		380	3.5		98	
23	13		14		1,200	7.9		200	
24	13		34		670	7.0		190	
25	11		160	**	1,000	9.2		160	
26	30		66		2,200	8.5		550	
27	21		43		4,300	10		330	
28	20		34		2,400	10		330	
Moser Bay-Subtidal									
29	4		12		590	2.1		71	
30	5		11		570	4.5		130	
WCSQV $_{(1)}$	**31**	a	**110**	a	**NA**	**11**	a	**550**	a
WCSQV $_{(2)}$	**31**	a	**120**	a	**NA**	**37**	a	**620**	a

Note: All concentrations reported on dry weight basis

*	-	concentration exceeds WCSQV $_{(1)}$
**	-	concentration exceeds WCSQV $_{(2)}$
BOD	-	biochemical oxygen demand
COD	-	chemical oxygen demand
CoPC	-	chemical of potential concern
NA	-	sediment quality values not available
TOC	-	total organic carbon
WCSQV$_{(1)}$	-	Ward Cove sediment quality value analogous to sediment quality standard
WCSQV$_{(2)}$	-	Ward Cove sediment quality value analogous to minimum cleanup level

[a] Site-specific sediment quality value.

Table 3. Summary of CoPCs for sediments in Ward Cove and Moser Bay in 1997 and comparison with sediment quality values

Station	TOC (percent)	Total Ammonia (mg/kg)	Total Sulfide (mg/kg)	BOD (g/kg)	COD (g/kg)	4-Methylphenol (Fg/kg)
Ward Cove-Subtidal						
2	33 **	85	4,500	45 **	12	15,000 **
3	30	80	500	46 **	10	6,200 **
4	25	150 **	3,700	64 **	13	4,500 **
5	38 **	57	2,300	9.2	5.6	16,000 **
7	26	120 *	1,900	8.0	10	7,500 **
11	19	34	2,300	14 *	16	380
12	21	240 **	1,900	6.4	7.8	8,300 **
13	22	320 **	2,700	12 *	7.0	1,700 *
16	28	40	12,000	13 *	16	1,200
17	28	99	50	10	10	570
18	4.0	13	310	1.6	2.2	26
19	17	110	5,500	8.5	11	730
22	4.0	19	560	3.5	6.5	24
23	9.0	86	3,900	37 *	26	170
25	13	120 *	3,800	34 *	30	6,600 **
27	20	47	4,500	34 *	12	470
28	19	34	4,400	32 *	5.6	802
31	21	510 **	11,000	11	13	17,000 **
32	23	82	13,000	9.1	7.1	2,700 **
33	5.1	23	1,600	1.7	4.5	980
34	29	120 *	2,300	10	12	5,100 **
35	30	120 *	3,300	14 *	10	460
37	31	54	2,700	7.1	8.7	4,400 **
38	34 **	260 **	6,700	65 **	15	8,300 **
39	23	110	2,700	7.7	8.3	1,300
40	23	80	3,800	7.8	11	1,000
41	22	58	48	6.4	52	640
42	24	82	2,000	6.9	11	5,700 **
43	18	110	9,700	7.4	10	1,000
44	26	690 **	2,300	13 *	15	9,000 **
45	21	170 **	4,800	9.1	12	2,400 **
47	26	120 *	3,000	7.1	7.9	1,800 **
48	25	300 **	3,900	9.2	19	1,100
Moser Bay-Subtidal						
29	3.6	16	240	1.7	3.5	10 *U*
30	5.3	18	530	3.0	4.5	15 *U*
Ward Cove-Intertidal						
50	1.3	3.2	20 *U*	0.7	1.3	10 *U*
51	5.1	11	1,000	8.7	6.2	231
WCSQV (1)	**31** [a]	**110** [a]	**NA**	**11** [a]	**550** [a]	**1,300** [a]
WCSQV (2)	**31** [a]	**120** [a]	**NA**	**37** [a]	**620** [a]	**1,700** [a]

Note: All concentrations reported on dry weight basis.

- C - concentration exceeds $WCSQV_{(1)}$
- ** - concentration exceeds $WCSQV_{(2)}$
- BOD - biochemical oxygen demand
- COD - chemical oxygen demand
- CoPC - chemical of potential concern
- NA - sediment quality values not available
- TOC - total organic carbon
- *U* - undetected at concentration listed
- $WCSQV_{(1)}$ - Ward Cove sediment quality value analogous to sediment quality standard
- $WCSQV_{(2)}$ - Ward Cove sediment quality value analogous to minimum cleanup level

[a] Site-Specific sediment quality value.

Table 4. Summary of CoPCs for sediments in Ward Cove and Moser Bay in 1996 and comparison with sediment quality values

	Metals			Organic Compounds			
Station	Cadmium (mg/kg dry weight)	Total Mercury (mg/kg dry weight)	Zinc (mg/kg dry weight)	Phenol (Fg/kg dry weight)	4-Methyl-phenol (Fg/kg dry weight)	2,3,7,8-TCDD[a] (Fg/kg organic carbon)	TCDD TEC [a,b] (F/g/kg orgainic carbon)
Ward Cove-Subtidal							
1	4.6	0.10	205	240	6,000 **	0.02	0.24
2	2.3	0.10 *U*	135	510 *	11,000 **	0.01 *U*	0.23
3	1.3	0.70 **	214	110	5,600 **	0.01 *U*	0.23
4	4.3	0.20	277	170	2,900 **	0.03	0.46
5	1.3	0.10 *U*	117	150	860	0.02 *U*	0.14
6	4.8	0.10	165	97	8,300 **	0.01 *U*	0.15
7	7.3 **	0.25	197	200 *U*	1,700 *	0.02 *U*	0.46
8	6.1 *	0.20	203	250 *U*	1,400 *	ND	ND
9	5.0	0.10	226	250 *U*	1,400 *	0.01 *U*	0.12
10	2.8	0.10 *U*	270	250 *U*	250 *U*	ND	ND
11	2.4	0.10 *U*	115	200 *U*	200 *U*	0.01 *U*	0.06
12	5.5 *	0.10	200	200 *U*	620	0.01	0.17
13	5.2 *	0.10	142	200 *U*	390	0.01 *U*	0.08
14	6.7 *	0.10	188	200 *U*	1,000	0.02	0.26
15	4.8	0.10	121	200 *U*	220	0.01 *U*	0.14
16	3.7 *	0.10 *U*	190	360	250 *U*	0.01 *U*	0.07
17	1.0	0.10 *U*	192	250 *U*	250 *U*	0.01 *U*	0.03
18	0.2	0.10 *U*	43	15	20 *U*	0.06 *U*	0.10
19	3.7	0.10	110	250 *U*	250 *U*	0.01 *U*	0.11
20	5.3 *	0.20	147	200 *U*	470	0.01 *U*	0.18
21	5.2 *	0.10	135	250 *U*	250 *U*	0.01 *U*	0.16
22	1.0	0.10 *U*	69	200 *U*	200 *U*	0.02 *U*	0.10
23	2.5	0.20	159	46	49	0.02 *U*	0.06
24	3.5	0.20	242	250 *U*	250 *U*	0.02 *U*	0.22
25	3.7	0.10	340	130	1,700 *	0.02 *U*	0.21
26	4.0	0.10	144	200 *U*	200 *U*	0.01 *U*	0.14
27	4.7	0.10	133	200 *U*	200 *U*	0.03 *U*	0.05
28	2.6	0.10 *U*	171	200 *U*	200 *U*	ND	ND
Moser Bay-Subtidal							
29	0.33	0.10 *U*	78	20 *U*	20 *U*	ND	ND
30	1.4	0.10 *U*	70	20 *U*	20 *U*	0.02 *U*	0.03
SQS/WCSQV(1)	**5.1** c	**0.41** c	**410** c	**420** c	**1,300** d	**NA**	**NA**
MCUL/WCSQV(2)	**6.7** c	**0.58** c	**960** c	**1,200** c	**1,700** d	**NA**	**NA**

Note:

*	-	concentration exceeds sediment quality standard
**	-	concentration exceeds minimum cleanup level
CoPC	-	chemical of potential concern
NA	-	sediment quality values not available
ND	-	no data
TCDD	-	tetrachlorodibenzo-*p*-dioxin
TEC	-	toxic equivalent concentration
TOC	-	total organic carbon
U	-	undetected at concentration listed
WCSQV(1)	-	Ward Cove sediment quality value analogous to sediment quality standard
WCSQV(2)	-	Ward Cove sediment quality value analogous to minimum cleanup level

[a] Concentrations are normalized to station-specific TOC concentrations, except that a TOC concentration of 10 percent was used for all station-specific values that were $\geq$ 10 percent.

[b] Detection limits are included in the sum at half their value.

[c] Washington State sediment management standard.

[d] Site-specific sediment quality value.

Table 5. Identification of CoCs for human health based on maximum estimated or measured seafood concentrations

Chemical	Maximum Sediment Concentration [a] (mg/kg dw)	Maximum Seafood Concentration [b] (mg/kg ww)	Oral CSF (mg/kg-day)$^{-1}$	Oral RfD (mg/kg-day)	Background Tissue Concentration (mg/kg ww)	Risk-Based Tissue Concentration [d] (mg/kg ww)	Identified as CoC for Human Health
Metals and Organometallic Compounds							
Arsenic [e]	39	0.12	1.5	0.0003	0.15 [e]	0.30	No
Cadmium	7.3	3.7	ND	0.001	NA	19	No
Total mercury (sediments; methylmercury in tissues)	0.7	0.07	ND	0.0001	NA [f]	1.9	No
Total mercury (measured)		0.026			NA [f]	1.9	No
Zinc	396	495	ND	0.3	NA	5,800	No
Organic Compounds							
Phenol	0.91	0.47	ND	0.6	NA	12,000	No
4-Methylphenol	17	8.8	ND	0.005	NA	96	No
PCDD/F (TEC)	4.6×10^{-5}	3.9×10^{-5}	150,000	ND	0.2×10^{-6} [g]	3.0×10^{-6}	Yes [h]
PCDD/F (TEC) (measured tissue data)		0.78×10^{-6} [i]			0.2×10^{-6} [g]	3.0×10^{-6}	No
PAHs							
Carcinogenic PAH (RPC)	0.41	0.072	7.3	ND	NA	0.42	No
Fluoranthene	2.2	0.39	ND	0.04	NA	5,300	No
Pyrene	1.8	0.32	ND	0.03	NA	4,000	No
Acenaphtene	0.50	0.088	ND	0.06	NA	8,000	No
Anthracene	0.26	00.46	ND	0.3	NA	40,000	No
Fluorene	0.47	0.083	ND	0.04	NA	5,300	No

Note: $\boxed{}$ - values updated with 1997 data

BSAF - biota-sediment accumulation factor
CoC - chemical of concern
CSF - carcinogenic slope factor
dw - dry weight
EPA - U.S. Environmental Protection Agency
NA - not available
ND - not determined by EPA or not considered to be a carcinogen
PAH - polycyclic aromatic hydrocarbon
PCDD/F - polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran
RfD - reference dose
RPC - relative potency concentration for carcinogenic PAHs
TEC - toxic equivalent concentration based on data for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin
ww - wet weight

[a] Concentrations are maximum sediment concentrations, except for phenol, PAHs (RPCs), anthracene, and zinc, which exclude higher sediment concentrations identified at locations remote from the side (i.e., Station 23 at the state airplane ramp and Stations 24 and 25 at the cannery). For undetected concentrations, one-half the detection limit was used in the RPC and TEC calculations.

[b] Concentrations estimated using BSAFs except data for PCDD/F (TECs) and mercury as indicated. Concentrations for all substances except PAHs were estimates for fish tissues. Higher estimated concentrations of some chemicals in shellfish would be offset by lower (or absent) site-related intake. PAHs were evaluated based on highest estimated shellfish concentrations because although PAHs may be taken up into fish, they also are rapidly metabolized and, thus, do not readily bioaccumulate in fishes.

Table 6. Summary of sediment toxicity results for Ward Cove and Moser Bay in 1996 and comparison with sediment quality values

Station	*Rhepoxynius abronius* Survival (percent)	*Leptocheirus plumulosus* Survival (percent)	*Neanthes* sp. Individual Growth Rate (mg/day)	*Dendraster excentricus* Normal Survival (percent)	*Dendraster excentricus* Embryo Normality (percent)
Ward Cove					
1	50 (32.2)**	93 (4.5)	0.59(0.12)	51(19.0)**	85 (11.1)*
2	7 (10.9)**	94 (4.2)	0.64(0.08)	55(10.1)**	93(5.5)
3	90 (7.9)	93 (5.7)	0.54(0.06)	51(25.6)**	88(11.9)*
4	64 (15.2)*	93 (6.7)	0.62(0.11)	56(19.5)**	87(9.6)*
5	25 (19.0)**	98 (2.7)	0.57(0.04)	48(28.1)**	74(26.6)*
6	5 (8.7)**	88 (6.7)	0.62(0.11)	54(21.4)**	92(7.1)
7	90 (7.9)	99 (2.2)	0.61(0.08)	61(13.5)*	86(12.4)*
8	43 (22.8)**	89 (13.9)	0.68(0.16)	58(13.9)**	89(11.1)*
9	54 (17.8)**	92 (7.6)	0.63(0.10)	43(23.0)**	92(6.8)[a]
10	75 (14.6)	96 (4.2)	0.67(0.16)	50(13.2)**	97(1.7)
11	94 (8.2)	97 (4.5)	0.54(0.11)	47(23.7)**	95(3.4)[a]
12	3 (2.7)**	93 (10.9)	0.63(0.07)	46(18.8)**	92(2.0)
13	36 (10.8)**	95 (6.1)	0.56(0.19)	52(14.6)**	96(3.2)
14	60 (20.9)**	98 (4.5)	0.70(0.14)	64(26.0)*	93(6.6)
15	67 (13.5)*	94 (6.5)	0.66(0.08)	67(8.9)*	97(1.8)
16	30 (15.4)**	98 (2.7)	0.68(0.11)	52(17.2)**	97(1.8)
17	88 (11.5)	94 (6.5)	0.51(0.10)	54(30.4)**	95(3.8)[a]
18	95 (5.0)	96 (4.2)	0.55(0.07)	58(13.4)**	94(4.6)
19	48 (18.9)**	100 (--)	0.65(0.06)	79(15.0)	94(5.8)
20	67 (16.4)*	97 (4.5)	0.59(0.09)	72(18.2)	96(2.5)
21	82 (16.0)	96 (4.2)	0.63(0.07)	80(9.3)	98(1.2)
22	84 (11.9)	92 (12.6)	0.57(0.10)	80(13.3)	94(7.6)
23	84 (6.5)	94 (4.2)	0.64(0.10)	59(18.9)*	95(5.3)
24	89 (8.2)	96 (6.5)	0.57(0.07)	71(16.4)*	89(12.5)
25	3 (4.5)**	96 (5.5)	0.74(0.09)	58(24.2)**	94(5.8)[a]
26	96 (4.2)	93 (4.5)	0.58(0.10)	75(9.2)	93(4.4)
27	85 (6.1)	98 (2.7)	0.65(0.10)	72(23.2)	95(3.2)[a]
28	69 (24.9)*	96 (5.5)	0.63(0.10)	67(8.6)*	94(2.1)
Moser Bay					
29	91 (4.2)	97 (2.7)	0.48(0.09)	83(17.6)	97(2.7)
30	93 (6.7)	99 (2.2)	0.72 (0.12)	86 (8.3)	97(2.8)

Note: Mean values are presented, with standard deviations in parentheses.

* S toxicity response is less than sediment quality standard (values provided in Section 7.2.1) or, for *Dendraster excentricus* normality, response is significantly less ($P \leq 0.05$) than the pooled results for Moser Bay

** toxicity response is less than minimum cleanup level (values provided in Section 7.2.1)

[a] Results are calculated from four replicate samples based on an outlier analysis discussed in the text.

Table 7. Summary of sediment toxicity results for Ward Cove and Moser Bay in 1997 and comparison with sediment quality values

Station	*Rhepoxy abronius* Survival (percent)	*Dendraster excentricus* Normal Survival (percent)	*Dendraster excentricus* Embryo Normality (percent)
Ward Cove			
2	9 (17.5)**	43 (20.6)**	91 (6.9)
3	65 (10.8)**[a]	53 (22.6)*	96 (0.8)
4	38 (28.4)**	56 (22.0)*	93 (4.9)
5	39 (22.5)**	53 (12.5)*	95 (3.3)
7	58 (15.7)**	59 (15.2)*	96 (3.8)
11	83 (7.6)	55 (12.8)*	96 (4.0)
12	14 (11.9)**	43 (14.4)**	94 (5.6)
13	15 (22.6)**	48 (5.4)**	97 (1.9)
16	89 (4.2)	32 (21.5)**	91 (9.5)
17	43 (39.9)**	57 (16.1)*	94 (4.0)
18	90 (7.1)	50 (23.1)**	97 (2.4)[a]
19	59 (12.9)**	61 (13.5)*	96 (1.9)
22	84 (13.4)	78 (14.0)	99 (1.1)
23	79 (18.8)	63 (22.6)	94 (4.7)
25	10 (14.1)**	56 (17.0)*	93 (2.4)
27	75 (17.3)[a]	38 (18.7)**	95 (3.2)[a]
28	73 (16.6)*[a]	58 (14.8)*	94 (6.9)
31	3 (4.5)**	28 (12.8)**	95 (4.5)
32	28 (32.5)**	54 (15.2)*	98 (2.4)
33	77 (11.0)	28 (11.9)**	95 (7.9)
34	39 (10.3)**[a]	50 (9.6)**	94 (5.2)
35	75 (17.0)	44 (9.5)**	97 (2.5)
37	65 (15.4)**	68 (17.0)	98 (2.5)
38	0 (0)**	50 (27.7)**	90 (9.5)
39	41 (11.1)**[a]	68 (14.1)	98 (1.7)
40	75 (5.8)[a]	76 (14.9)	97 (4.0)
41	90 (6.1)	41 (19.9)**	97 (3.7)
42	68 (16.8)*	57 (9.0)*	97 (1.8)
43	72 (15.3)*	59 (6.8)*	97 (4.3)
44	1 (2.2)**	52 (13.6)*	96 (1.7)
45	54 (37.0)**	48 (12.5)**	92 (7.2)
47	73 (16.1)*	49 (10.0)**	97 (3.5)
48	5 (7.1)**	56 (6.1)*	97 (2.6)
Moser Bay			
29	96 (2.2)	74 (11.4)	97 (2.1)
30	96 (4.2)	73 (16.9)	98 (1.1)

Note: Mean values are presented, with standard deviations in parentheses.

* - toxicity response is less than sediment quality standard (values provided in Section 7.2.1) or, for *Dendraster exentricus* normality, response is significantly less ($P \leq 0.05$) than the pooled results for Moser Bay

** - toxicity response is less than minimum cleanup level (values provided in Section 7.2.1)

[a] Results are calculated from four replicate samples based on an outlier analysis discussed in the text.

Table 8. Summary results of food-web assessment for avian and mammalian receptors in Ward Cove based on maximum and mean sediment concentrations of CoPCs

		Hazard Quotient Based on Maximum Concentration					Hazard Quotient Based on Mean Concentration			
Compound	**Maximum Sediment Concentration (mg/kg)**	**Harbor Seal**	**River Otter**	**Marbled Murrelet**	**Pelagic Cormorant**	**Mean Sediment Concentration (mg/kg)**	**Harbor Seal**	**River Otter**	**Marbled Murrelet**	**Pelagic Cormorant**
Arsenic	39	0.009	0.13	0.0012	$6.8x10^{-4}$	22	0.005	0.071	$6.5x10^{-4}$	$3.9x10^{-4}$
Cadmium	7.3	0.04	0.31	1.07	0.11	3.5	0.02	0.15	0.52	0.055
Mercury	0.7	0.009	0.15	0.11	0.048	0.1	0.001	0.021	0.016	0.007
Zinc	396	0.011	0.14	0.16	0.11	190	0.005	0.068	0.078	0.053
PCDDs/Fs	$4.6x10^{-5}$	0.17	1.96	0.12	0.077	$1.7x10^{-5}$	0.06	0.72	0.043	0.028
PAHs	0.41	$1.9x10^{-5}$	$5.1x10^{-4}$	ND	ND	0.16	$7.6x10^{-6}$	$2.0x10^{-4}$	ND	ND

Note:

CoPC	-	chemical of potential concern
ND	-	not determined
PAH	-	polycyclic aromatic hydrocarbon
PCDD/F	-	polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran

Table 9. Environmental studies in Ward Cove

Date	Summary of study	Reference
1951-1952	Water column, plankton, and benthic macroinvertebrate data were collected	AWPCB (1953)
1955-1957	Impacts to benthic macroinvertebrates and fish were observed	AWPCB (1957)
1965	Low dissolved oxygen was found in surface and bottom water	FWPCA (1965)
1968-1969	Impacts to benthic macroinverteberates and blue mussels were observed	FWQA (1970)
1974	Improvements in water quality and benthic macroinvertebrates were observed; sediment chemical concentrations were measured for the first time	U.S. EPA (1975
1988	Sediment toxicity was found to be associated with sulfides and oxygen demand, but not with metals	Jones & Stokes and Kinnetic (1989)
1992	Sediment toxicity was observed, and the benthic macroinvertebrate assemblage was considered characteristic of areas affected by organic enrichment	EVS (1992)
1994-1995	Spatial distributions of sediment chemicals, organic material, and sediment toxicity were related to the KPC mill	ENSR (1995)
1996-1997	Sediment CoPCs, toxicity, and physical characteristics were evaluated to support remedy selection	Exponent (1999)

Note: CoPC - chemical of potential concern
KPC - Ketchikan Pulp Company

Table 10. Summary of surface sediment data collected in Ward Cove and Moser Bay in 1996 and 1997

Analyte	Concentration Range	Median	Number of Detected Values	Number of Samples	Frequency of Detection (percent)	Station with Maximum Concentration	Year in Which Maximum Value Was Detected	
							1996	1997
Conventional Analytes								
Acid-volatile sulfide (mg/kg)	240 ! 17,000	2,450	28	28	100	16		X
Total ammonia (mg/kg)	3.2 ! 690	83	72	72	100	44	X	
Biochemical oxygen demand 5-day test (g/kg)	0.72 ! 65	9.2	72	72	100	38		X
Chemical oxygen demand (g/kg)	1.3 ! 2,400	17	72	72	100	8	X	
Total sulfide (mg/kg)	20 *U* ! 27,000	2,500	71	72	99	17	X	
Total organic carbon (percent)	1.1 ! 41	23	72	72	100	2	X	
Gravel (percent)[a]	0 *U* ! 61	2.0	71	72	99	50		X
Sand (percent)								
1.0-2.0 mm	0.27 ! 20	2.7	72	72	100	18	X	
0.50-1.0 mm	0.53 ! 20	5.3	72	72	100	33		X
0.25-0.50 mm	0.8 ! 17	9.0	72	72	100	33		X
0.125-0.25 mm	0.79 ! 16	10	72	72	100	16	X	
0.062-0.125 mm	1.9 ! 35	9.5	72	72	100	29		X
Silt (percent)	4.5 ! 78	37	72	72	100	30		X
Clay (percent)	1.5 ! 34	21	72	72	100	44		X
Total solids (percent of wet weight)	12 ! 80	19	72	72	100	50		X
Extractable organic halides (mg/kg)	10 *U* ! 79	44	4	29	14	25		X
Metals								
Arsenic (mg/kg)	2.7 ! 39	21	31	31	100	7	X	
Cadmium (mg/kg)	0.14 ! 7.3	3.5	49	49	100	7	X	
Methylmercury (*m*g/kg)	0.22 ! 14.3	0.90	28	28	100	23		X
Total mercury (mg/kg)	0.1 *U* - 0.7	0.20	20	49	41	3	X	
Zinc (mg/kg)	39 ! 530	159	49	49	100	25		X
Semivolatile Organic Compounds (*m*g/kg)								
Low molecular weight PAHs								
Naphthalene	1 ! 440	50	26	32	81	3	X	
2-Methylnaphthalene	10 *U* ! 280	53	25	32	78	3	X	
Acenaphthylene	10 *U* ! 110	20	7	32	22	23	X	
Acenaphthene	10 *U* ! 500	40	19	32	59	3	X	
Fluorene	10 *U* ! 470	46	25	32	78	3	X	
Phenanthrene	6 ! 1,100	230	30	32	94	3	X	
Anthracene	3 ! 380	57	27	32	84	25	X	
Total	10 *U* ! 2,800	470	32	32	100	3	X	
High molecular weight PAHs								
Fluoranthene	10 *U* ! 2,200	390	30	32	94	4		X

Table 10. (cont)

Analyte	Concentration Range	Median	Number of Detected Values	Number of Samples	Frequency of Detection (percent)	Station with Maximum Concentration	Year in Which Maximum Value Was Detected	
							1996	1997
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	0.73 ! 30	8.7	31	42	74	4		X
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	2 *U* ! 920	290	38	42	90	4	X	
Octachlrodibenzo-*p*-dioxin	11 ! 6,300	2,100	41	42	98	4		X
Total tetrachlorodibenzo-*p*-dioxins	0.66 *U* ! 290	66	37	42	88	4	X	
Total pentachlorodibenzo-*p*-dioxins	0.66 *U* ! 160	37	35	42	83	4		X
Total hexachlorodibenzo-*p*-dioxins	0.86 *U* ! 390	120	37	42	88	4	X	
Total heptachlorodibenzo-*p*-dioxins	4.3 ! 3,100	800	42	42	100	4	X	
2,3,7,8-Tetrachlorodibenzofuran	0.58 *U* ! 36	9.1	9	42	21	7	X	
1,2,3,7,8-Pentachlordibenzofuran	0.55 *U* ! 9.7	3.0	21	42	50	4	X	
2,3,4,7,8-Pentachlorodibenzofuran	0.58 *U* ! 20	3.7	25	42	60	7	X	
1,2,3,4,7,8-Hexachlorodibenzofuran	0.66 *U* ! 85	5.7	8	42	19	7	X	
1,2,3,6,7,8-Hexachlorodibenzofuran	0.61 *U* ! 39	4.0	24	42	57	7	X	
1,2,3,7,8,9-Hexachlorodibenzofuran	1.0 *U* ! 4.5 *U*	2.1	0	42	0	--		
2,3,4,6,7,8-Hexachlorodibenzofuran	0.73 *U* ! 30	4.0	17	42	40	7	X	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.78 *U* ! 310	48	39	42	93	24	X	
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.98 *U* ! 27	3.6	11	42	26	7	X	
Octachlorodibenzofuran	2.6 *U* ! 390	145	38	42	90	4		X
Total tetrachlorodibenzofurans	0.58 *U* ! 230	52	36	42	86	4		X
Total pentachlorodibenzofurans	0.6 *U* ! 170	35	34	42	81	7	X	
Total hexachlorodibenzofurans	0.86 *U* ! 370	69	36	42	86	7	X	
Total heptachlorodibenzofurans	0.87 *U* ! 640	155	39	42	93	24	X	
Dioxin and furan toxic equivalent concentration[c]	1.1 ! 46	15	42	42	100	7	X	
Dioxin and furan toxic equivalent concentration[d]	0 *U* ! 45	12	42	42	100	7	X	

Note: Results are presented on a dry weight basis unless noted otherwise.

Concentrations for conventional analytes and organic compounds are rounded to two significant figures. Concentrations for metals are rounded to three significant figures if over 10 and two significant figures if less than 10.

Field replicates were treated as unique data points and the results were not averaged.

Medians were calculated using the detection limits for those congeners that were undetected.

-- - not applicable; the analyte was not detected at any station
PAH - polycyclic aromatic hydrocarbon
RPC - relative potency concentration
U - undetected at concentration listed

[a] When grain-size distribution is determined by the analytical laboratory, the term "gravel" is a designation for a specific size fraction in the sediment. This verbiage does not mean that the sediment is gravel. In some shallower parts of the Cove, the "gravel" size fraction could consist of wood debris and probably includes organic material.

[b] At least one detection limit exceeded the concentration of the indicated maximum detected value.

[c] Detection limits are included in tie sum at half their value.

Table 11. Summary of subsurface sediment data collected in Ward Cove in 1997 (excluding native sediments)

Analyte	Concentration Range	Median	Number of Detected Values	Number of Samples	Frequency of Detection (percent)	Station with Maximum Concentration	Interval of Maximum (in.) Upper Depth	Interval of Maximum (in.) Lower Depth
Conventional Analytes								
Total ammonia (mg/kg)	1.6 ! 4,200	330	33	33	100	6	79	105
Biochemical oxygen demand 5-day test (g/kg)	3.0 ! 120	7.5	33	33	100	6	0	39
Chemical oxygen demand (g/kg)	1.3 ! 140	7.8	33	33	100	6	0	39
Total sulfide (mg/kg)	290 ! 55,000	2,700	32	32	100	16	79	91
Total organic carbon (percent)	10 ! 40	31	33	33	100	1	39	79
Gravel (percent)[a]	0.5 ! 61	7.4	33	33	100	5	39	70
Sand (percent)								
1.0-2.0 mm	1.3 ! 13	5.4	33	33	100	2	39	79
0.50-1.0 mm	1.3 ! 33	6.4	33	33	100	9	39	79
0.25-0.50 mm	2.7 ! 37	9.5	33	33	100	9	39	79
0.125-0.25 mm	1.7 ! 19	7.9	33	33	100	36	0	22
0.062-0.125 mm	1.2 ! 24	7.6	33	33	100	36	0	22
Silt (percent)	4.8 ! 61	26	33	33	100	7	0	39
Clay (percent)	8.9 ! 37	20	33	33	100	6	0	39
Total solids (percent of wet weight)	11 ! 30	19	33	33	100	36	0	22
Metals (mg/kg)								
Cadmium	0.36 ! 4.3	2.0	33	33	100	8	0	39
Total mercury	0.2 *U* ! 0.7	0.2	7	33	21	4	0	39
Zinc	35 ! 224	120	33	33	100	9	0	39
Phenols (*m*g/kg)								
Phenol	54 ! 4,700	340	33	33	100	6	0	39
4-Methylphenol	180 ! 78,000	3,300	33	33	100	6	0	39
Dioxins and Furans (ng/kg)								
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin	0.6 *U* ! 1.3 *U*	0.7	0	5	0	--	NA	NA
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	0.96 *U* ! 1.6 *U*	1.4	0	5	0	--	NA	NA
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	1.0 ! 1.5[b]	1.3	4	5	80	D	NA	NA
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	2.0 ! 4.7	3.7	5	5	100	D	NA	NA
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	1.6 *U* ! 3.3	2.3	2	5	40	A	NA	NA
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	49 ! 86	72	5	5	100	A	NA	NA
Octachlorodibenzo-*p*-dioxin	390 ! 670	530	5	5	100	A	NA	NA
Total tetrachlorodibenzo-*p*-dioxins	17 ! 61	46	5	5	100	B	NA	NA
Total pentachlorodibenzo-*p*-dioxins	4.4 ! 21	14	5	5	100	D	NA	NA
Total hexachloodibenzo-*p*-dioxins	17 ! 44	35	5	5	100	D	NA	NA
Total heptachlorodibenzo-*p*-dioxins	120 ! 190	180	5	5	100	A	NA	NA
2,3,7,8-Tetrachlorodibenzofuran	3.1 *U* ! 4.7 *U*	4.3	0	5	0	--	NA	NA

Table 12. Comparison of native and non-native subsurface sediment data Collected in Ward Cove in 1997

Analyte	Native Sediment (4 samples)		Non-native Sediment (33 samples)	
	Concentration Range	Frequency of Detection (percent)	Concentration Range	Frequency of Detection (percent)
Conventional Analytes				
Total amonia (mg/kg)	8.6 ! 180	100	1.6 ! 4,200	100
Biochemical oxygen demand 5-day test (g/kg)	0.2 *U* ! 2.1	75	3.0 ! 120	100
Chemical oxygen demand (g/kg)	0.2 ! 5.4	100	1.3 ! 140	100
Total sulfide (mg/kg)	3.3 ! 770	100[a]	290 ! 55,000	100
Total organic carbon (percent)	0.36 ! 12	100	10 ! 40	100
Gravel (percent)[b]	0.1 ! 37	100	0.5 ! 61	100
Sand (percent)				
1.0 - 2.0 mm	0.3 ! 6.6	100	1.3 ! 13	100
0.50 - 1.0 mm	0.5 ! 5.5	100	1.3 ! 33	100
0.25 - 0.50 mm	2.7 ! 8.3	100	2.7 ! 37	100
0.125 - 0.25 mm	3.8 ! 13	100	1.7 ! 19	100
0.062 - 0.125 mm	9.5 ! 19	100	1.2 ! 24	100
Silt (percent)	16 ! 69	100	4.8 ! 61	100
Clay (percent)	6 ! 30	100	8.9 ! 37	100
Total solids (percent of wet weight)	23 ! 68	100	11 ! 30	100
Metals (mg/kg)				
Cadmium	0.11 ! 3.4	100	0.36 ! 4.3	100
Total mercury	0.2 *U*	0	0.2 *U* ! 0.7	21
Zinc	56.8 ! 96.3	100	35 ! 220	100
Phenols (*m*g/kg)				
Phenol	10 *U* ! 150	75	54 ! 4,700	100
4-Methyphenol	10 *U* ! 350	50	180 ! 78,000	100

Note: Results are presented on a dry weight basis unless noted otherwise.

Concentrations for conventional analytes and organic compounds are rounded to two significant figures.

Concentrations for metals are rounded to three significant figures if over 10 and two significant figures if less than 10.

U - undetected at concentration listed

[a] Only three native samples were analyzed for sulfide.

[b] When grain-size distribution is determined by the analytical laboratory, the term "gravel" is a designation for a specific size fraction in the sediment. This verbiage does not mean that the sediment is gravel. In some shallower parts of the Cove, the "gravel" size fraction could consist of wood debris and probably includes organic material.

Table 13. Risk-based concentration algorithm for fish and shellfish consumption

Risk-based concentration (carcinogenic effects) (mg/kg ww) =

$$\frac{TR \times AT_c \times BW}{CF \times EF \times ED \times FI \times IR \times CSF}$$

Risk-based concentration (noncarcinogenic effects) (mg/kg ww) =

$$\frac{THQ \times AT_n \times BW \times RfD}{CF \times EF \times ED \times FI \times IR}$$

Where:

TR = target risk (unitless)
THQ = target hazard quotient (unitless)
CF = conversion factor (kg/g)
EF = exposure frequency (days/year)
ED = exposure duration (years)
FI = fraction ingested from contaminated source (unitless)
IR = ingestion rate of fish/shellfish (g/day)
BW = body weight (kg)
AT = averaging time:
- carcinogenic effects: 70 years x 365 days/year
- noncarcinogenic effects: ED x 365 days/year

CSF = carcinogenic slope factor $(mg/kg\text{-}day)^{-1}$ (chemical specific)
RfD = reference dose (mg/kg-day) (chemical specific)

Exposure Assumptions[a]

Paremeter	
TR	1×10^{-5} [b]
THQ	1
CF	1×10^{-3}
EF	350
ED	30
FI	0.05[c]
BW	70

	Fish	Shellfish
IR[d]	65	11

[a] Algorithms and exposure assumptions from U.S. EPA (1989,1991b), unless otherwise specified.
[b] Based on the draft ADEC (1998) guidance.
[c] Based on best professional judgment.
[d] Ingestion rates represent average seafood consumption rates for a subsistence community in the Ketchikan area.

Table 14. Summary of result used to determine AET values for TOC[a]

1996				1997			
Station	Concentration[b] (percent dry weight)	Amphipod Test	Echinoderm Test	Station	Concentration[b] (percent dry weight)	Amphipod Test	Echinoderm Test
5	36	X	X	5	38	X	X
6	33	X	X	38	34	X	X
1	32	X	X	2	33	X	X
16	31	X	X	37	31	X	–[d]
17	31	–[c]	X	3	30	X	X
26	30	--	--	35	30	--	X
9	27	X	X	34	29	X	X
10	27	--	X	16	28	--	X
4	26	X	X	17	28	X	X
7	26	--	X	47	26	X	X
14	25	X	X	44	26	X	X
15	25	X	X	7	26	X	X
8	24	X	X	48	25	X	X
12	24	X	X	4	25	X	X
3	22	--	X	42	24	X	X
13	22	X	X	39	23	X	--
21	21	--	--	40	23	--	--
27	21	--	--	32	23	X	X
28	20	X	X	13	22	X	X
19	18	X	--	41	22	--	X
20	17	X	--	31	21	X	X
2	14	X	X	12	21	X	X
11	14	--	X	45	21	X	X
23	13	--	X	27	20	--	X
24	13	--	X	11	19	--	X
25	11	X	X	28	19	X	X
22	5	--	--	43	18	X	X
18	1	--	X	19	17	X	X
				25	13	X	X
				23	9	--	--
				33	5	--	X
				18	4	--	X
				22	4	--	--

Note: AET - apparent effects threshold
TOC - total organic carbon
X - toxicity response was less than the sediment quality standard (SQS), indicating that an adverse effect was present
-- - toxicity response was greater than the SQS, indicating that no adverse response was present

[a] Chemical concentrations are also presented in Table 2 and 3 and toxicity responses and associated SQS comparisons are presented in Table 6 and 7.

[b] Concentrations are listed in rank order.

[c] AET for the amphipod test.

[d] AET for the echinoderm test.

Table 15. Summary of result used to determine AET values for total ammonia[a]

1996				1997			
Station	Concentration[b] (mg/kg dry weight)	Amphipod Test	Echinoderm Test	Station	Concentration[b] (mg/kg dry weight)	Amphipod Test	Echinoderm Test
6	360	X	X	44	690	X	X
1	310	X	X	31	510	X	X
12	260	X	X	13	320	X	X
2	220	X	X	48	300	X	X
25	160	X	X	38	260	X	X
13	150	X	X	12	240	X	X
14	130	X	X	45	170	X	X
8	100	X	X	4	150	X	X
10	99	--	X	35	120	–[c]	X
4	97	X	X	34	120	X	X
21	88	--	--	47	120	X	X
20	84	X	--	7	120	X	X
15	83	X	X	25	120	X	X
9	82	X	X	39	110	X	–[d]
16	81	X	X	43	110	X	X
7	74	--	X	19	110	X	X
5	67	X	X	17	99	X	X
26	66	--	--	23	86	--	--
11	50	--	X	2	85	X	X
19	44	X	--	42	82	X	X
27	43	--	--	32	82	X	X
24	34	--	X	3	80	X	X
28	34	X	X	40	80	--	--
22	21	--	--	41	58	--	X
3	14	--	X	5	57	X	X
23	14	--	X	37	54	X	--
18	13	--	X	27	47	--	X
17	11	--	X	16	40	--	X
				11	34	--	X
				28	34	X	X
				33	23	--	X
				22	19	--	--
				18	13	--	X

Note: AET - apparent effects threshold
X - toxicity response was less than the sediment quality standard (SQS), indicating that an adverse effect was present
-- - toxicity response was greater than the SQS, indicating that no adverse response was present

[a] Chemical concentrations are also presented in Table 2 and 3 and toxicity responses and associated SQS comparisons are presented in Table 6 and 7.

[b] Concentrations are listed in rank order.

[c] AET for the amphipod test.

[d] AET for the echinoderm test.

Table 16. Summary of result used to determine AET values for BOD[a]

1996				1997			
Station	Concentration[b] (g/kg dry weight)	Amphipod Test	Echinoderm Test	Station	Concentration[b] (g/kg dry weight)	Amphipod Test	Echinoderm Test
9	19	X	X	38	65	X	X
16	18	X	X	4	64	X	X
1	16	X	X	3	46	X	X
14	16	X	X	2	45	X	X
6	13	X	X	23	37	--[c]	--[d]
4	12	X	X	25	34	X	X
8	12	X	X	27	34	--	X
20	11	X	--[e]	28	32	X	X
5	10	X	X	11	14	--	X
12	10	X	X	35	14	--	X
27	10	--	--	16	13	--	X
28	10	X	X	44	13	X	X
2	9.9	X	X	13	12	X	X
10	9.8	--	X	31	11	X	X
19	9.6	X	--	34	10	X	X
25	9.2	X	X	17	10	X	X
7	8.7	--	X	48	9.2	X	X
26	8.5	--	--	5	9.2	X	X
13	8.3	X	X	32	9.1	X	X
23	7.9	--	X	45	9.1	X	X
17	7.6	--	X	19	8.5	X	X
3	7.3	--	X	7	8.0	X	X
24	7.0	--	X	40	7.8	--	--
11	6.4	--	X	39	7.7	X	--
21	6.2	--	--	43	7.4	X	X
15	6.0	X	X	47	7.1	X	X
22	3.5	--	--	37	7.1	X	--
18	1.4	--	X	42	6.9	X	X
				12	6.4	X	X
				41	6.4	--	X
				22	3.5	--	--
				33	1.7	--	X
				18	1.6	--	X

Note:
AET - apparent effects threshold
BOD - biochemical oxygen demand
X - toxicity response was less than the sediment quality standard (SQS), indicating that an adverse effect was present
-- - toxicity response was greater than the SQS, indicating that no adverse response was present

[a] Chemical concentrations are also presented in Table 2 and 3 and toxicity responses and associated SQS comparisons are presented in Table 6 and 7.

[b] Concentrations are listed in rank order.

[c] AET for the amphipod test.

[d] This no-effect concentration was not used to set the AET because it is considered a chemical anomaly (i.e., it is more than three times greater than the next highest no-effect concentration)

[e] AET for the echinoderm test.

Table 17. Summary of result used to determine AET values for COD[a]

1996				1997			
Station	Concentration[b] (g/kg dry weight)	Amphipod Test	Echinoderm Test	Station	Concentration[b] (g/kg dry weight)	Amphipod Test	Echinoderm Test
8	2,400	X	X	41	52	--	X
7	620	--[c]	X	25	30	X	X
16	620	X	X	23	26	--	--
5	590	X	X	48	19	X	X
9	550	X	X	16	16	--	X
26	550	--	--[d]	11	16	--	X
6	540	X	X	44	15	X	X
12	520	X	X	38	15	X	X
15	490	X	X	31	13	X	X
1	480	X	X	4	13	X	X
4	470	X	X	45	12	X	X
13	440	X	X	34	12	X	X
21	420	--	--	2	12	X	X
10	340	--	X	27	12	--	X
2	330	X	X	19	11	X	X
27	330	--	--	42	11	X	X
28	330	X	X	40	11	--	--
19	270	X	--	35	10	--	X
3	250	--	X	3	10	X	X
23	200	--	X	43	10	X	X
11	190	--	X	17	10	X	X
14	190	X	X	7	10	X	X
24	190	--	X	37	8.7	X	--
25	160	X	X	39	8.3	X	--
17	150	--	X	47	7.9	X	X
20	120	X	--	12	7.8	X	X
22	98	--	--	32	7.1	X	X
18	17	--	X	13	7.0	X	X
				22	6.5	--	--
				5	5.6	X	X
				28	5.6	X	X
				33	4.5	--	X
				18	2.2	--	X

Note:
AET - apparent effects threshold
COD - chemical oxygen demand
X - toxicity response was less than the sediment quality standard (SQS), indicating that an adverse effect was present
-- - toxicity response was greater than the SQS, indicating that no adverse response was present

[a] Chemical concentrations are also presented in Table 2 and 3 and toxicity responses and associated SQS comparisons are presented in Table 6 and 7.

[b] Concentrations are listed in rank order.

[c] AET for the amphipod test.

[d] AET for the echinoderm test.

Table 18. Summary of result used to determine AET values for 4-Methylphenol[a]

1996				1997			
Station	Concentration[b] (Fg/kg dry weight)	Amphipod Test	Echinoderm Test	Station	Concentration[b] (Fg/kg dry weight)	Amphipod Test	Echinoderm Test
2	11,000	X	X	31	17,000	X	X
6	8,300	X	X	5	16,000	X	X
1	6,000	X	X	2	15,000	X	X
3	5,600	–[c]	X	44	9,000	X	X
4	2,900	X	X	12	8,300	X	X
7	1,700	–[d]	X	38	8,300	X	X
25	1,700	X	X	7	7,500	X	X
8	1,400	X	X	25	6,600	X	X
9	1,400	X	X	3	6,200	X	X
14	1,00	X	X	42	5,700	X	X
5	860	X	X	34	5,100	X	X
12	620	X	X	4	4,500	X	X
20	470	X	--	37	4,400	X	–[c]
13	390	X	X	32	2,700	X	X
10	250 *U*	--	X	45	2,400	X	X
16	250 *U*	X	X	47	1,800	X	X
17	250 *U*	--	X	13	1,700	X	X
19	250 *U*	X	--	39	1,300	X	–[e]
21	250 *U*	--	--	16	1,240	--	X
24	250 *U*	--	X	48	1,100	X	X
15	220	X	X	40	1,000	--	--
11	200 *U*	--	X	43	1,000	X	X
22	200 *U*	--	--	33	980	--	X
26	200 *U*	--	--	28	802	X	X
27	200 *U*	--	--	19	730	X	X
28	200 *U*	X	X	41	640	--	X
23	49	--	X	17	570	X	X
18	20 *U*	--	X	27	472	--	X
				35	460	--	X
				11	380	--	X
				23	168	--	--
				18	26	--	X
				22	24	--	--

Note: AET - apparent effects threshold
X - toxicity response was less than the sediment quality standard (SQS), indicating that an adverse effect was present
-- - toxicity response was greater than the SQS, indicating that no adverse response was present

[a] Chemical concentrations are also presented in Table 2 and 3 and toxicity responses and associated SQS comparisons are presented in Table 6 and 7.

[b] Concentrations are listed in rank order.

[c] This no-effect concentration was not used to set the AET because it is considered a chemical anomaly (i.e., it is more than three times greater than the next highest no-effect concentration)

[d] AET for the amphipod test.

[e] AET for the echinoderm test.

Table 19. Cost estimates for remedial alternatives

Alternative[a]	Estimated Capital Cost[b]	Estimated Operation and Maintenance Cost[c]	Estimated "In-water" Cleanup Time[d]	Estimated Time to Meet Remedial Action Objectives
A2	$0	$450,000	0 months	8 to more than 20 years
B Option 1 B Option 2	$4,010,000[e] $5,180,000[f]	$450,000	6 months	Active Remediation - less than 10 years Natural Recovery - 8 to more than 20 years
C	$16,440,000	$450,000	Over 1 year	Same as Alternative B
D	$32,300,000	$450,000	Over 1 year	Same as Alternative B
E	$29,280,000	$450,000	Over 1 year	Same as Alternative B

[a] Alternatives as originally described in the RI/FS.

[b] Costs were based on thin-layer capping of 40 acres, and represent total present worth (1999). The accuracy of costs is estimated to be +50 percent to -30 percent.

[c] Estimated present net worth of 10 years of long-term monitoring costs.

[d] "In-water" refers to the time period that construction-related activities occur in the field (e.g., barges are placing capping material).

[e] Disposal of dredged material at Ketchikan Pulp Company landfill

[f] Disposal of dredged material at Washington state landfill.

Table 20. Cost estimate summary for the selected remedy

Construction Cost

Item	Quantity		Unit Cost		Cost
Placement of cap sand (21.3 acres)	17,200 cy	$	17.50	$	301,000
Placement of mound sand (6.0 acres)	24,200 cy	$	17.50	$	423,500
Delivery of sand to dockside	41,400 cy	$	25.00	$	1,035,000
Dredging/debris removal	20,550 cy	$	28.00	$	575,400
Placement in KPC Landfill	20,550 cy	$	16.00	$	328,800
Off-loading of logs	335 tons	$	60.00	$	20,100
Chipping of logs at KPC	335 tons	$	15.00	$	5,025
Mobilization/demobilization	1 lump sum	$	80,000.00	$	80,000
Field overhead	4 lump sum	$	15,000.00	$	60,000
Water quality monitoring	85 days	$	1,500.00	$	127,500
Construction cost				$	2,956,325
Contingency				$	443,449
Construction Estimate				$	3,399,774

Summary	Direct Costs		Percentage		Cost		
Cap/mound 27.3 Acres	$	1,759,500	66	$	2,229,115	Cap Unit Cost	$ 81,653 per acre
Dredge/disposal 20,550 cy	$	904,200	34	$	1,170,658		
Sum	$	2,663,700.00	100	$	3,399,774	Dredging/Upland Disposal Unit Cost	$ 56.97 per cy

Non-Construction Costs

Item		Unit Cost		Cost
Design			$	237,984
Capping/dredging monitoring	$	2,430.00	$	206,550
Construction management			$	118,992
Non-Construction Estimate			$	563,526
Total Estimated Capital Costs			**$**	**3,963,300**
Periodic Monitoring Costs				
Monitoring every other year for 10 years	$	120,000.00	$	400,000
Present worth of 10 years monitoring				
Total Estimated Costs			**$**	**4,363,300**

Note: cy - cubic yard
KPC - Ketchikan Pulp Company

Capital cost estimates are not discounted because the construction work is assumed to be performed in the first year. Monitoring costs are reported as present worth estimates given a 7 percent discount rate for a 10 year duration. Cost estimates are within +50 to - 30 percent accuracy expectation.

F:\WORK\KPC\ROD\rodtables.wpd

Figures

FIGURES

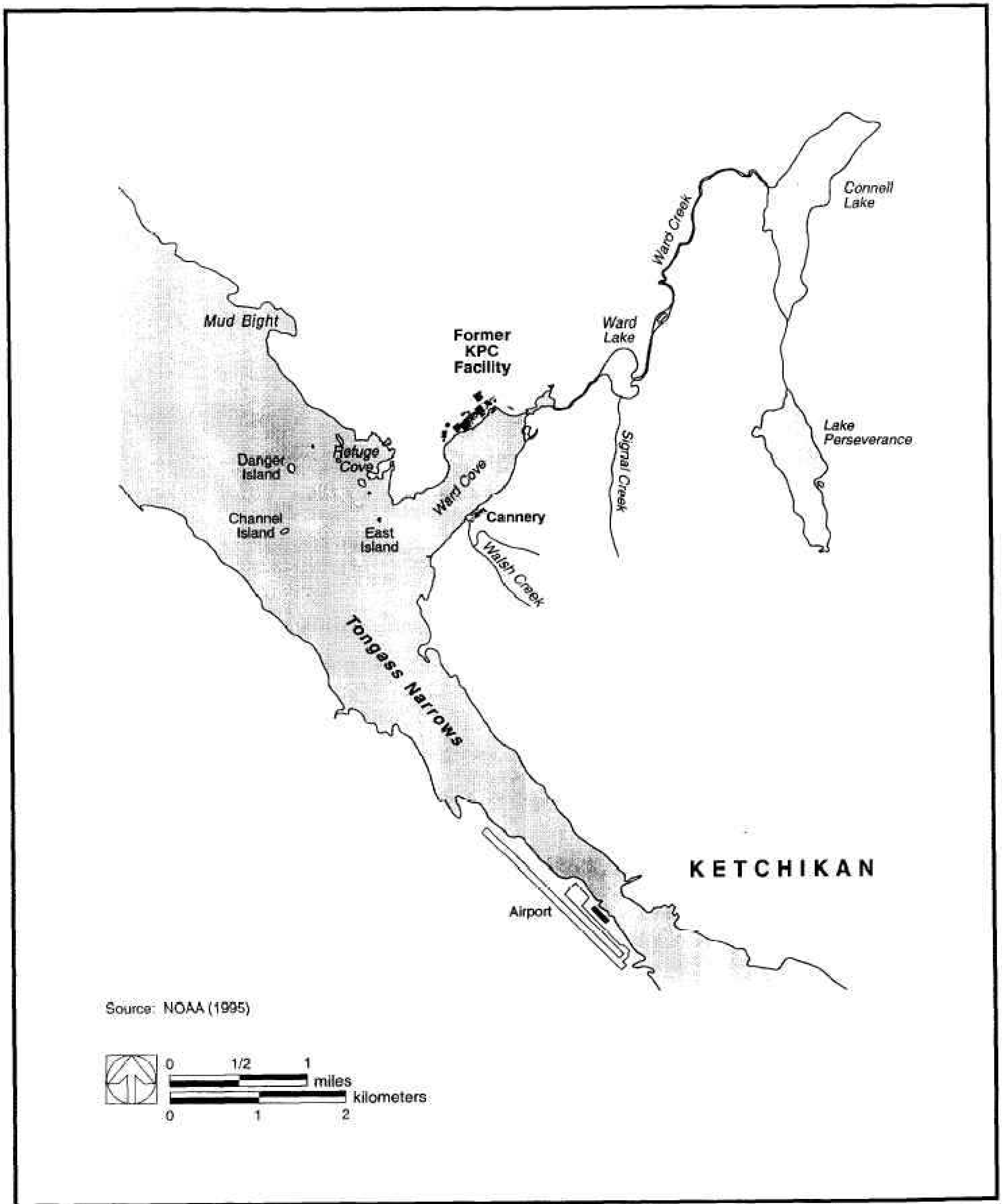
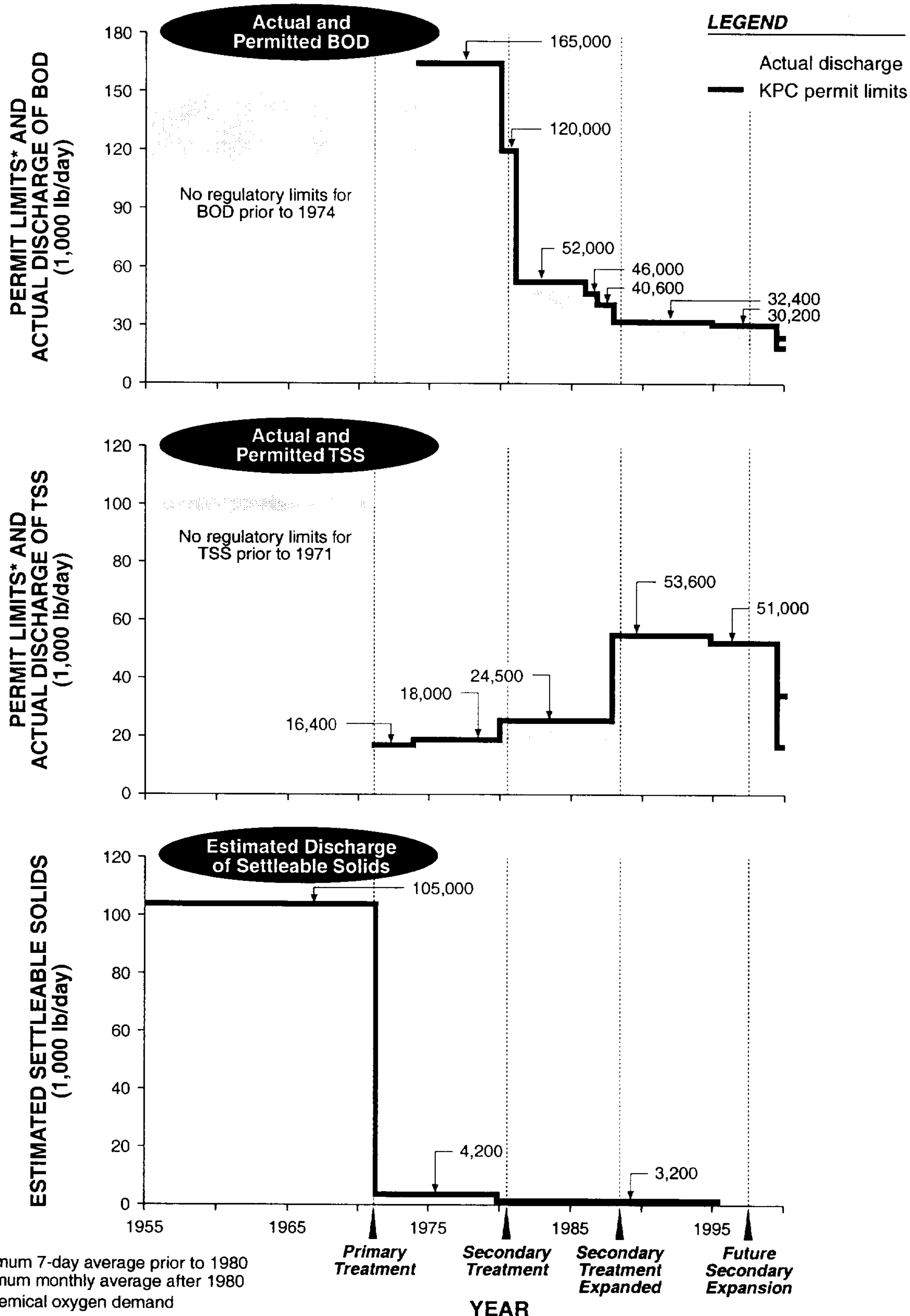


Figure 1. Location of Ward Cove



* Maximum 7-day average prior to 1980
Maximum monthly average after 1980
BOD Biochemical oxygen demand
TSS Total suspended solids
Source: Higgins and Amoth (1995)

Figure 2. Improvements to KPC effluent quality since facility startup

8600BOW.001 2302 01/04/00 WA

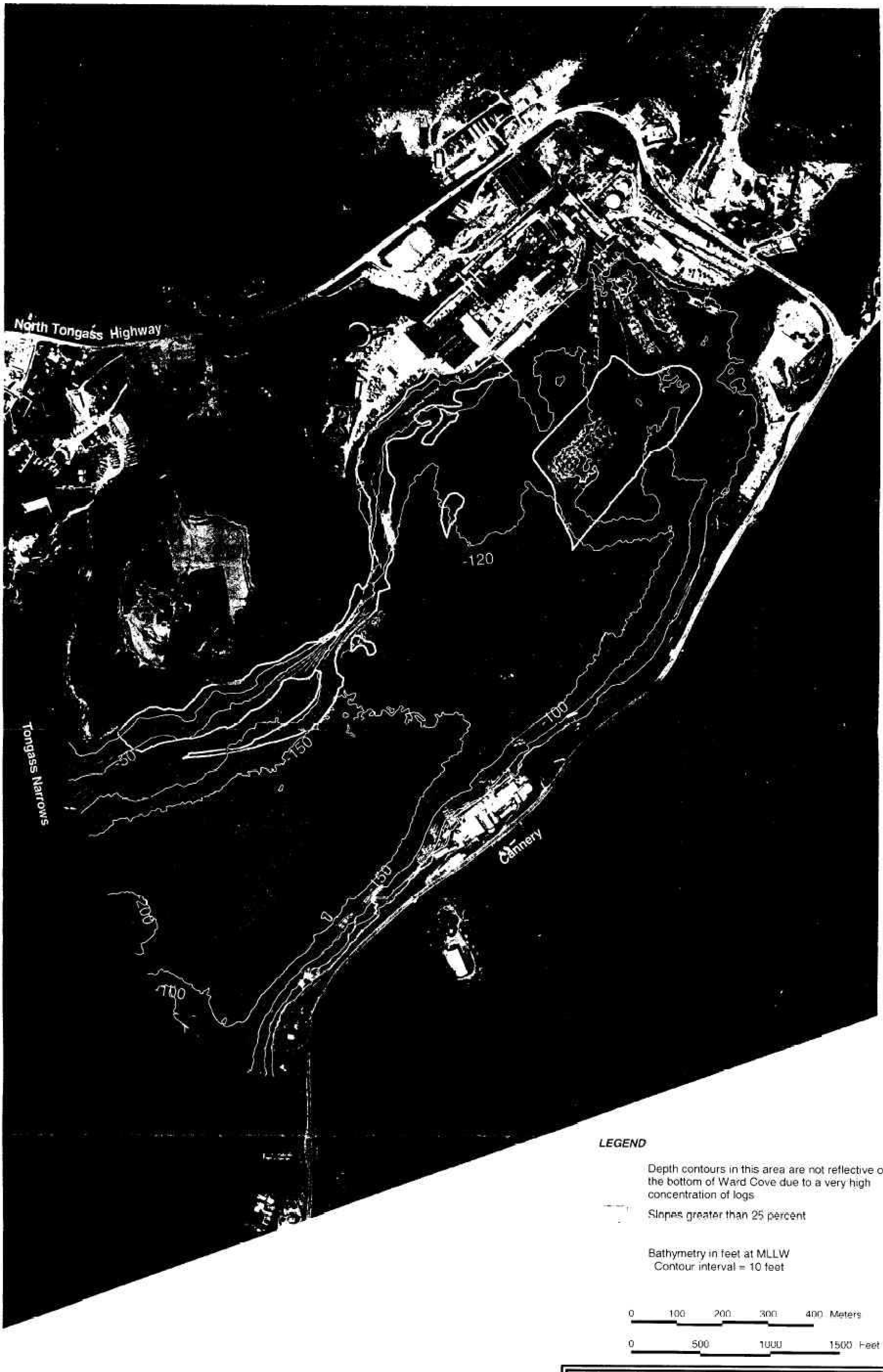


Figure 3. Ward Cove bathymetry

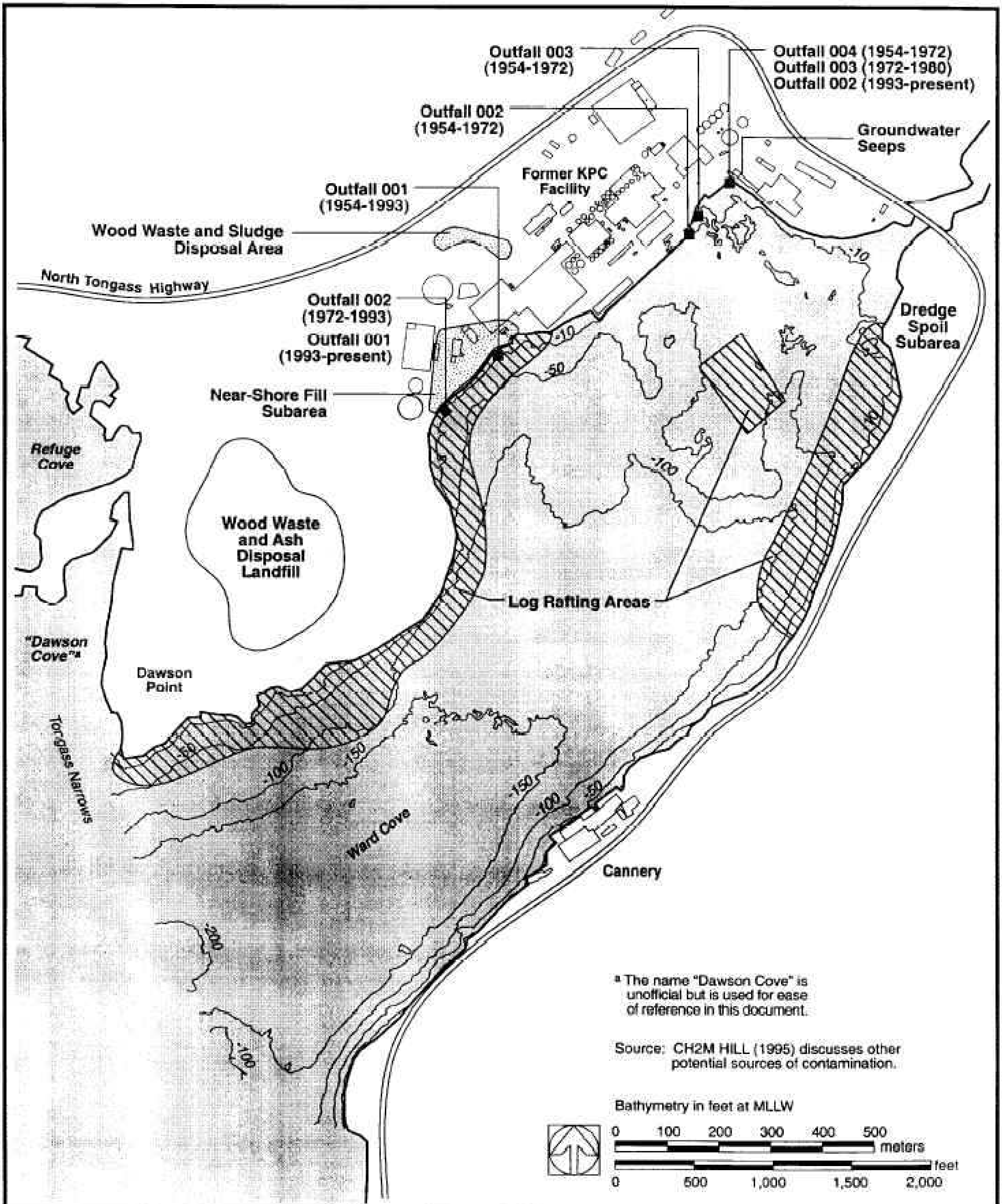


Figure 4. Potential sources of CoPCs to Ward Cove

8600BOW.001 2302 01/04/00 WA

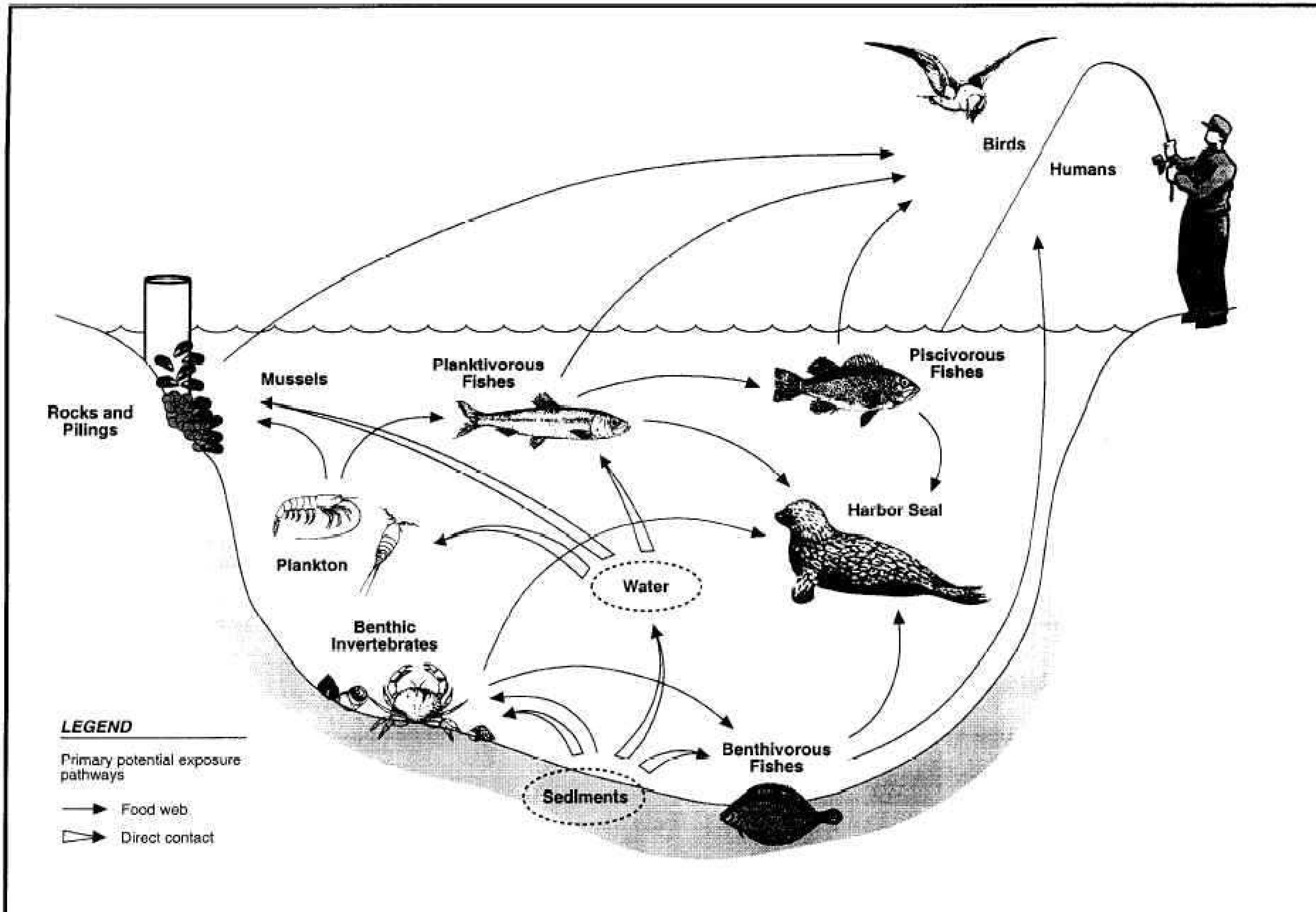


Figure 5. Conceptual model of potential exposure pathways from Ward Cove sediments.

8600BOW.001 1602 03/20/00 WA

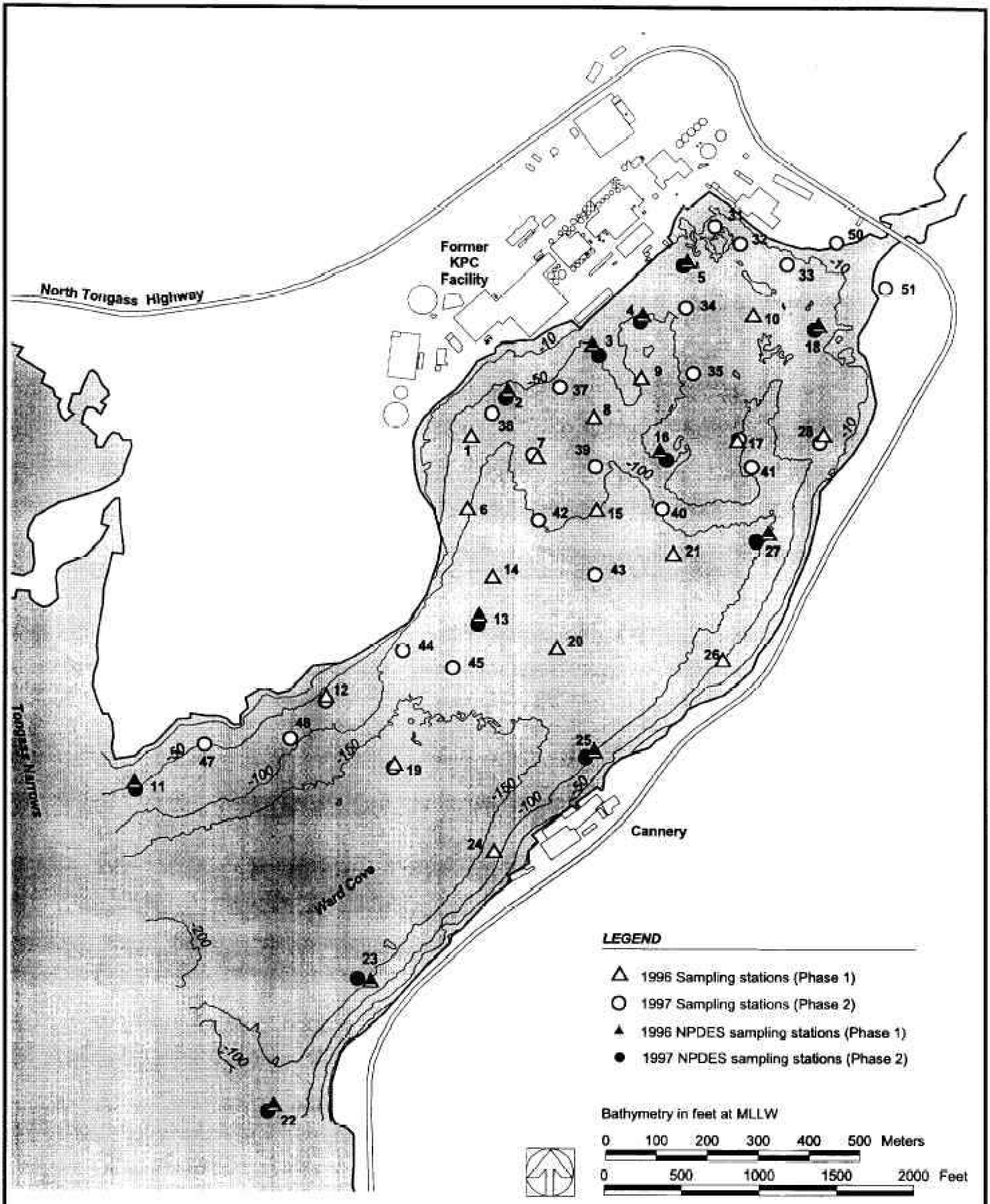


Figure 6. Station locations in Ward Cove at which surface sediment samples were collected in 1996 and 1997.

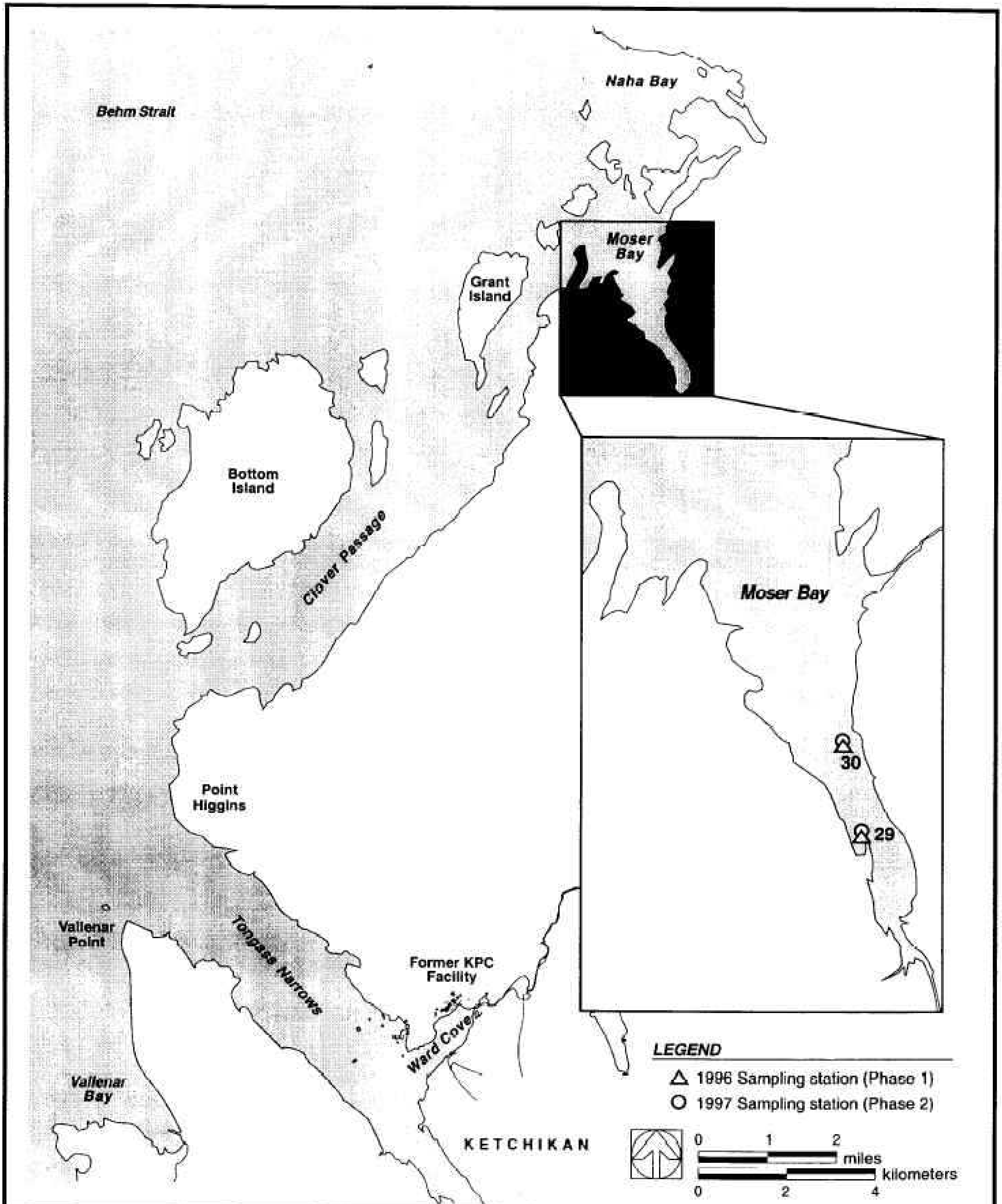


Figure 7. Station locations in Moser Bay at which surface sediments were collected in 1996 and 1997.

8500BOW.001 1502 03/20/00 WA

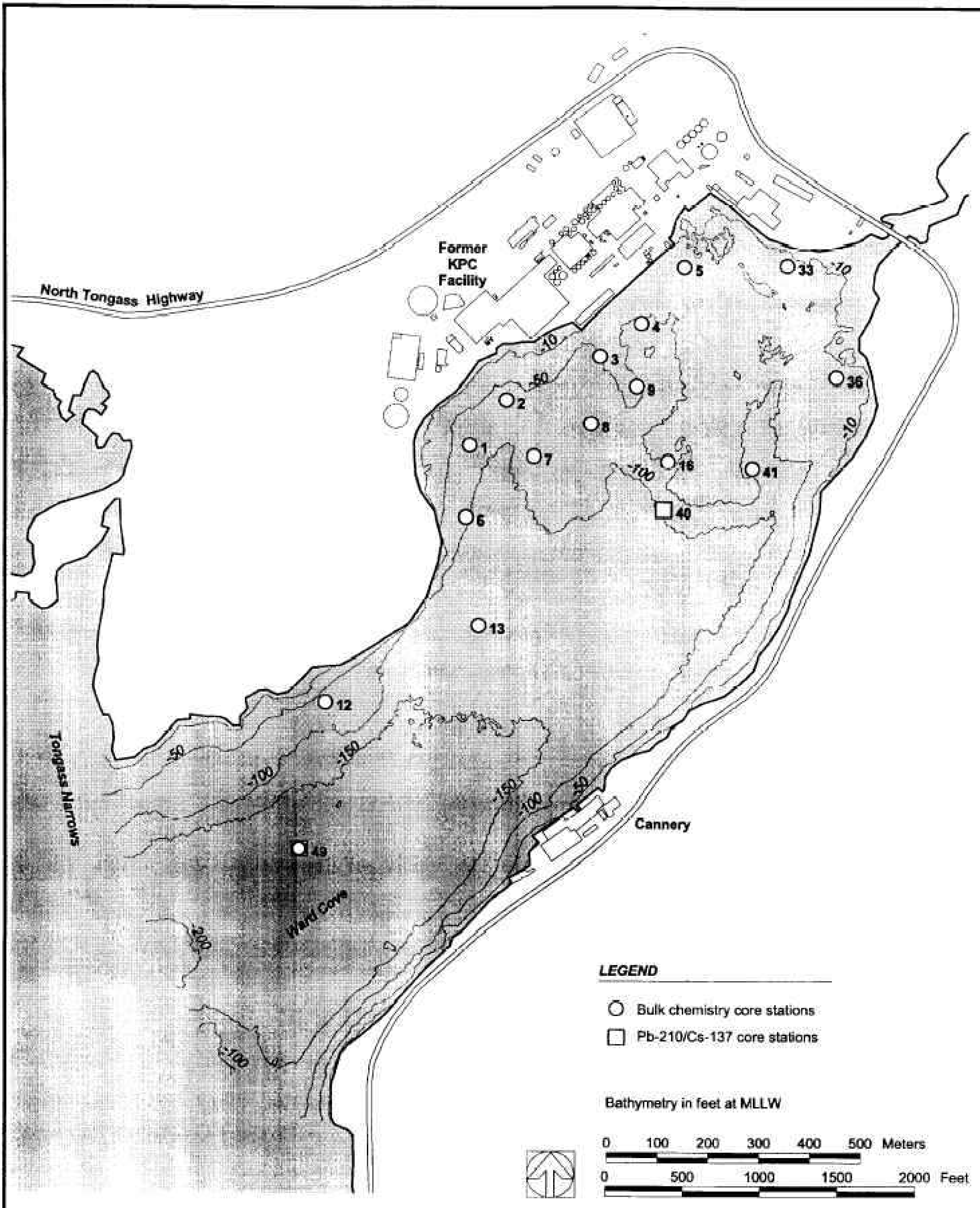


Figure 8. Station locations in Ward Cove at which sediment core samples were collected in 1997.

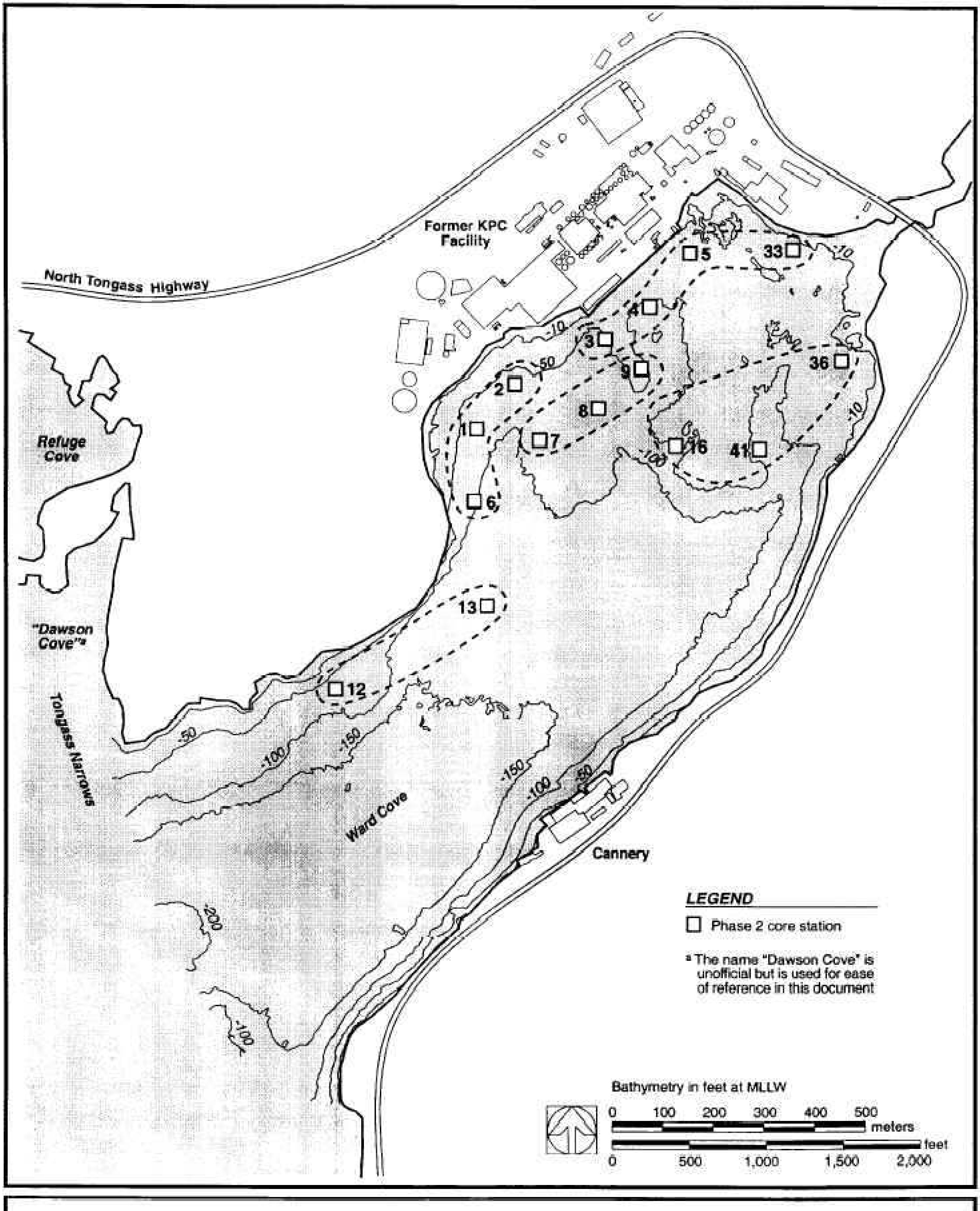


Figure 9. Station locations in Ward Cove at which sediment composites were collected for dioxin and furan analysis in 1997.

8600BOW.001 1602 03/20/00 WA

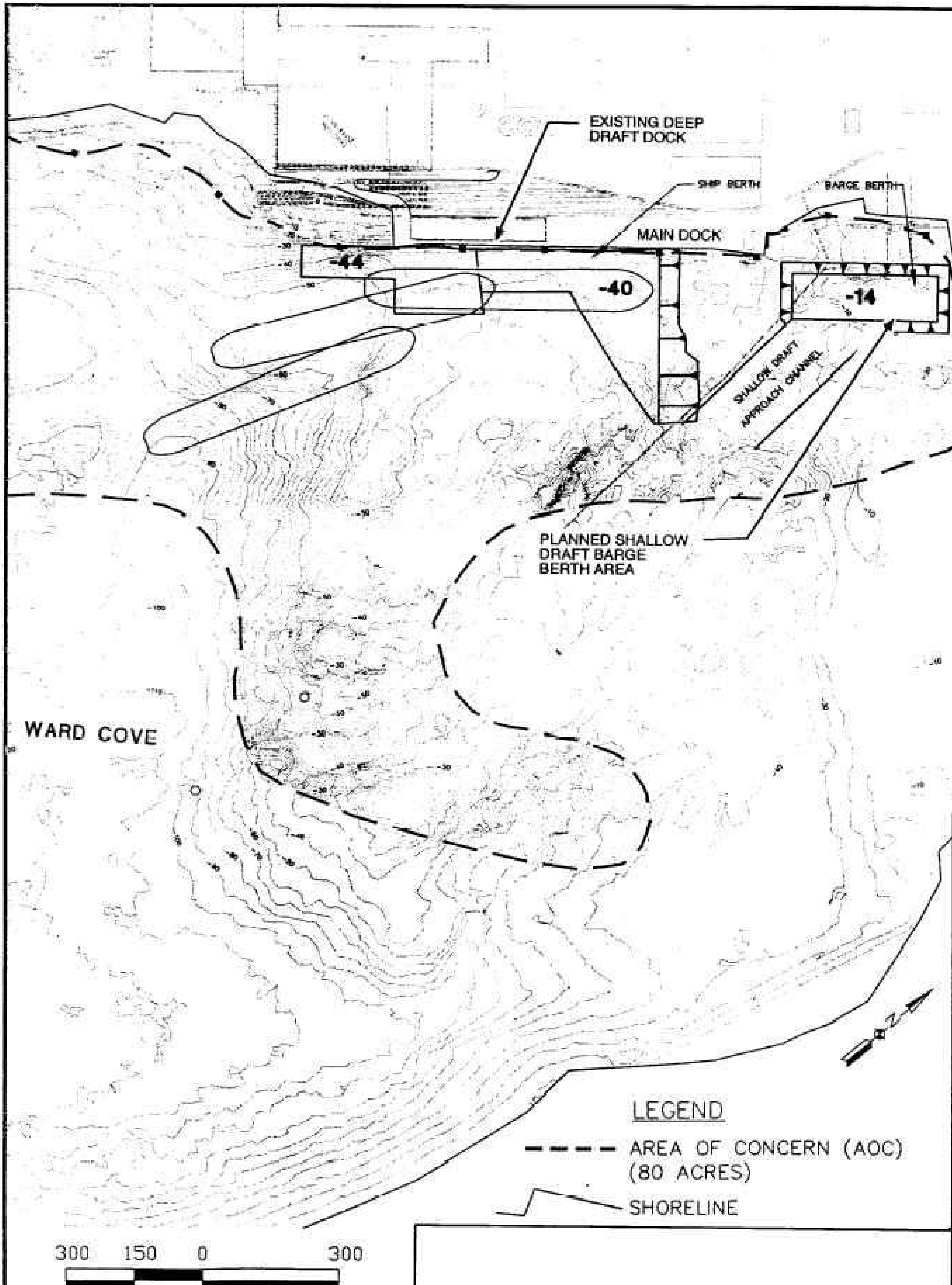


Figure 10. Navigation channel design

I:\PROJECTS\H3183002\DWG\MWDCFG08.DWG
PLOT/UPDATE: MAR 03 2000 09:00:11

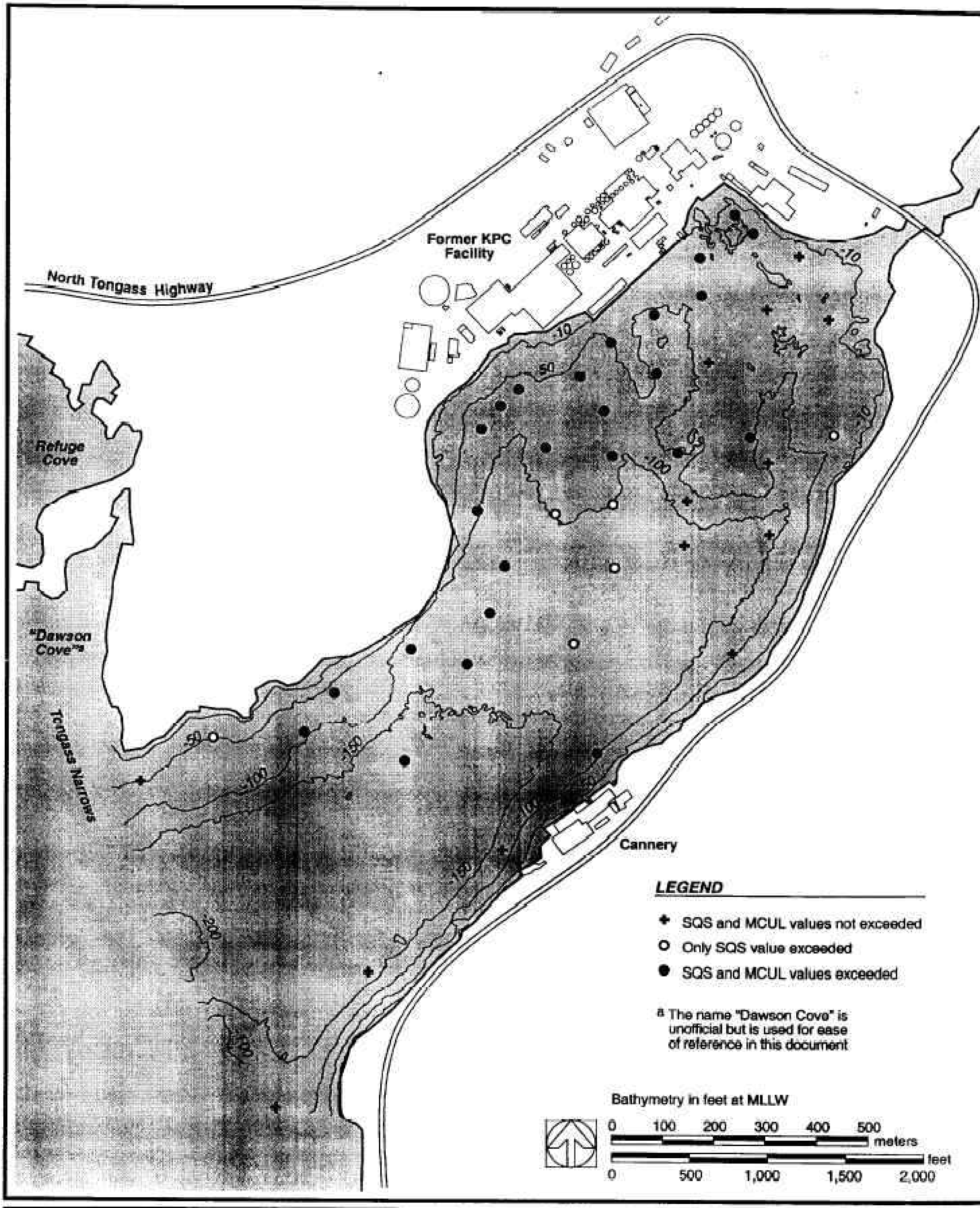


Figure 11. Distribution of exceedances of SQS and MCUL values for the amphipod test in Ward Cove in 1996 and 1997

8600BOW.001 2302 03/20/00 WA

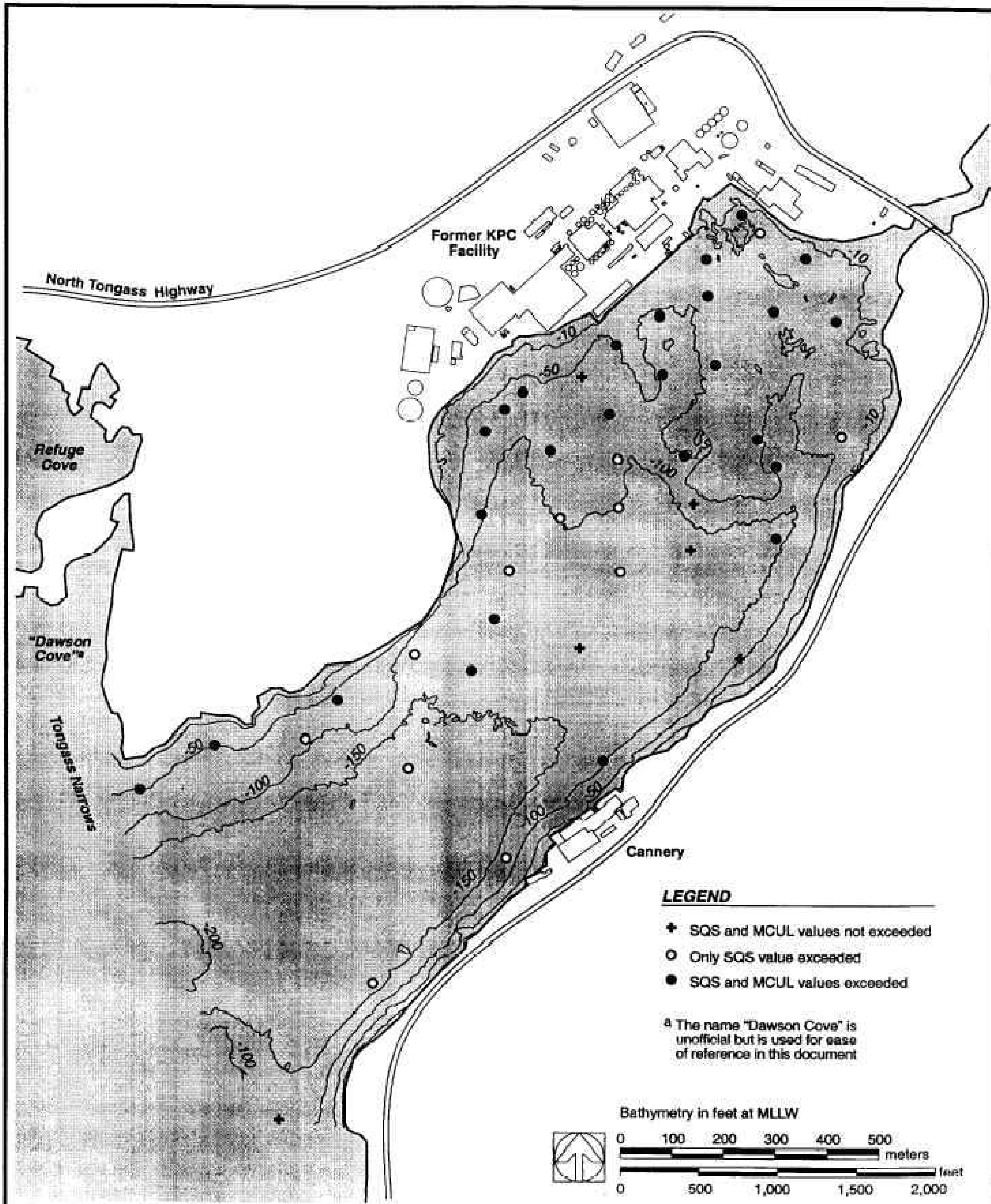


Figure 12. Distribution of exceedances of SQS and MCUL values for the echinoderm embryo test in Ward Cove in 1996 and 1997

8600BOW.001 2302 03/20/00 WA

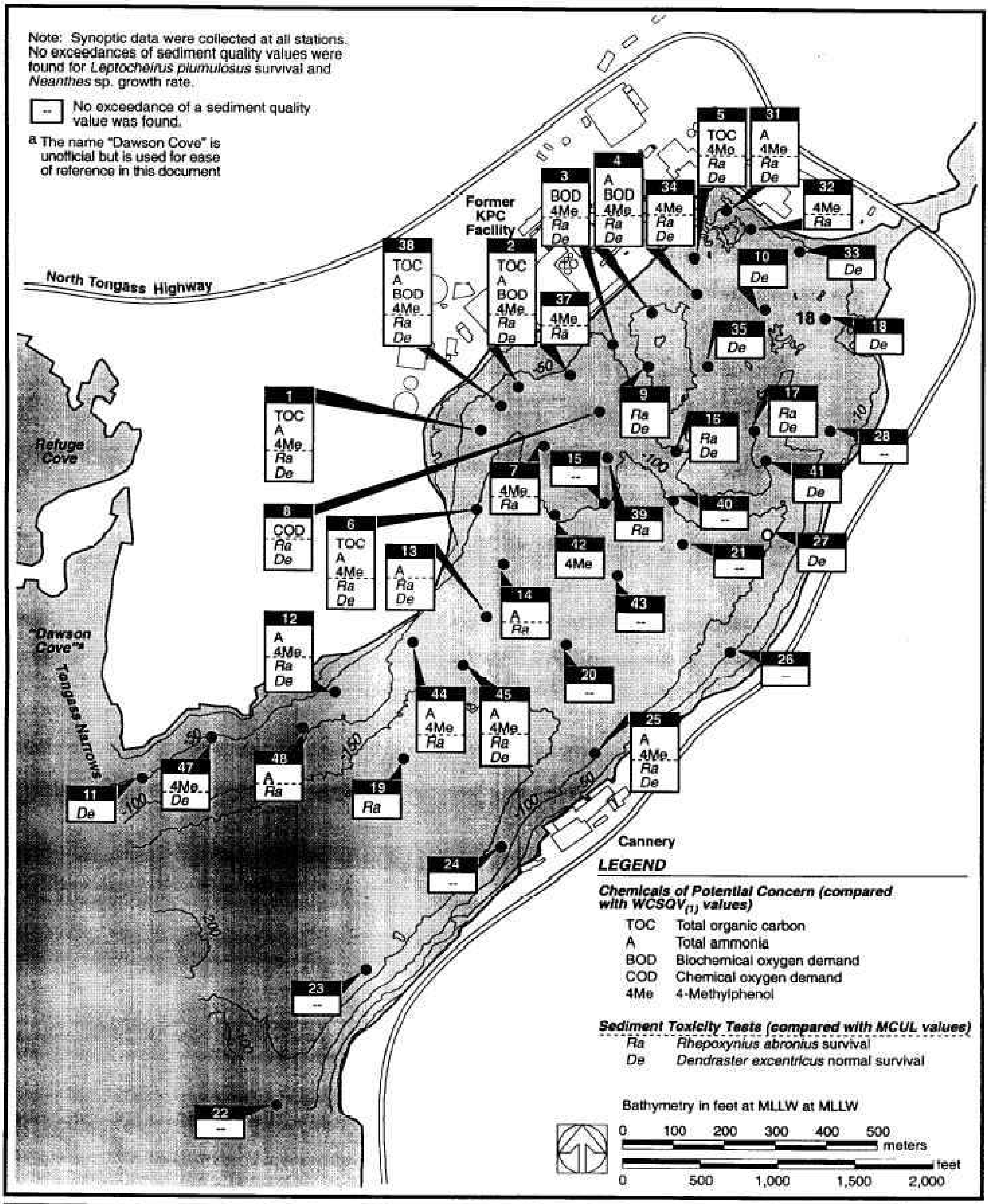


Figure 13. Distribution of exceedances of MCUL and WCSQV$_{(2)}$ values in Ward Cove in 1996 and 1997.

8600BOW.001 1602 03/20/00 WA

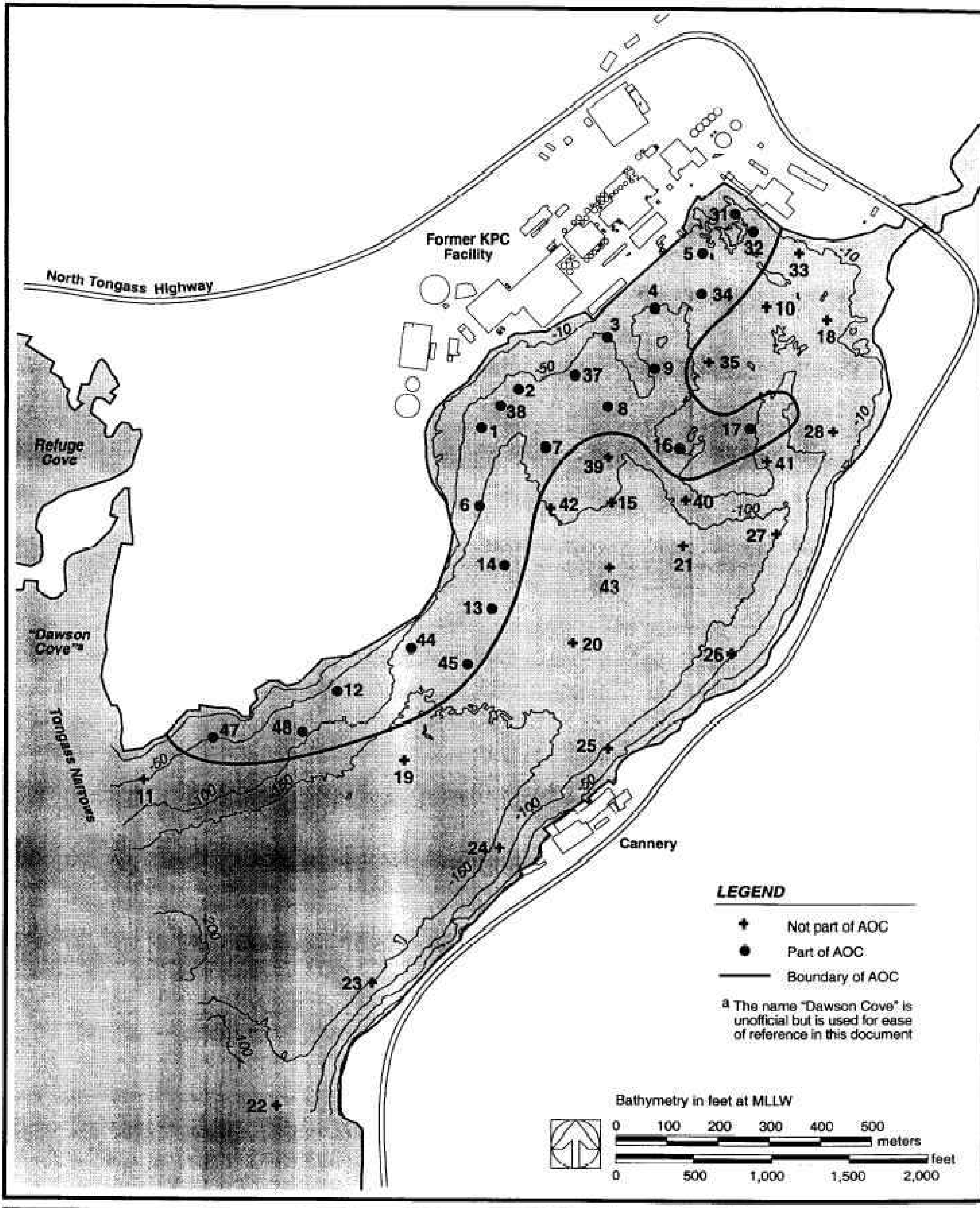
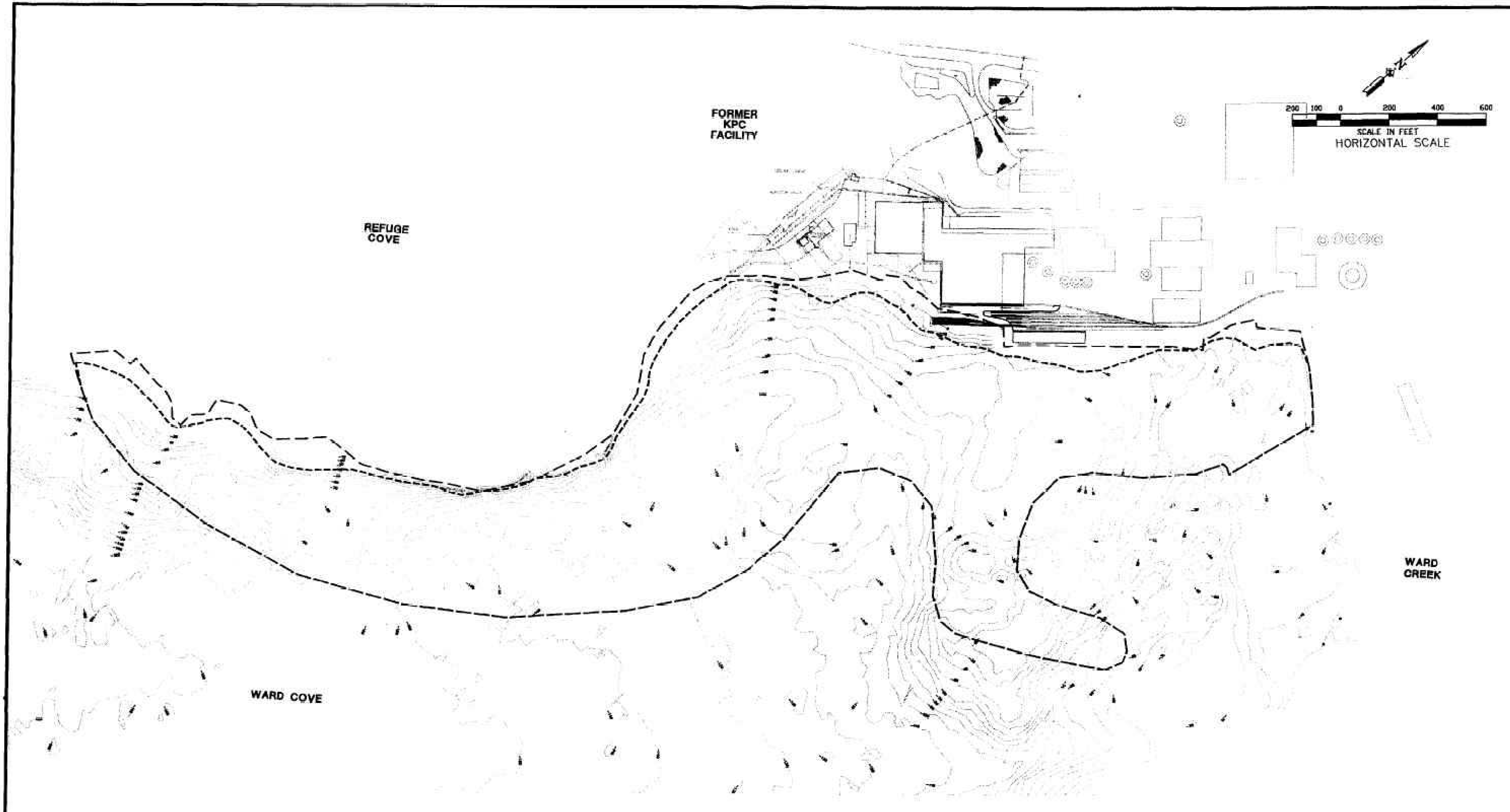


Figure 14. Delineation of area of concern for further evaluation.

8600BOW.001 1602 03/20/00 WA

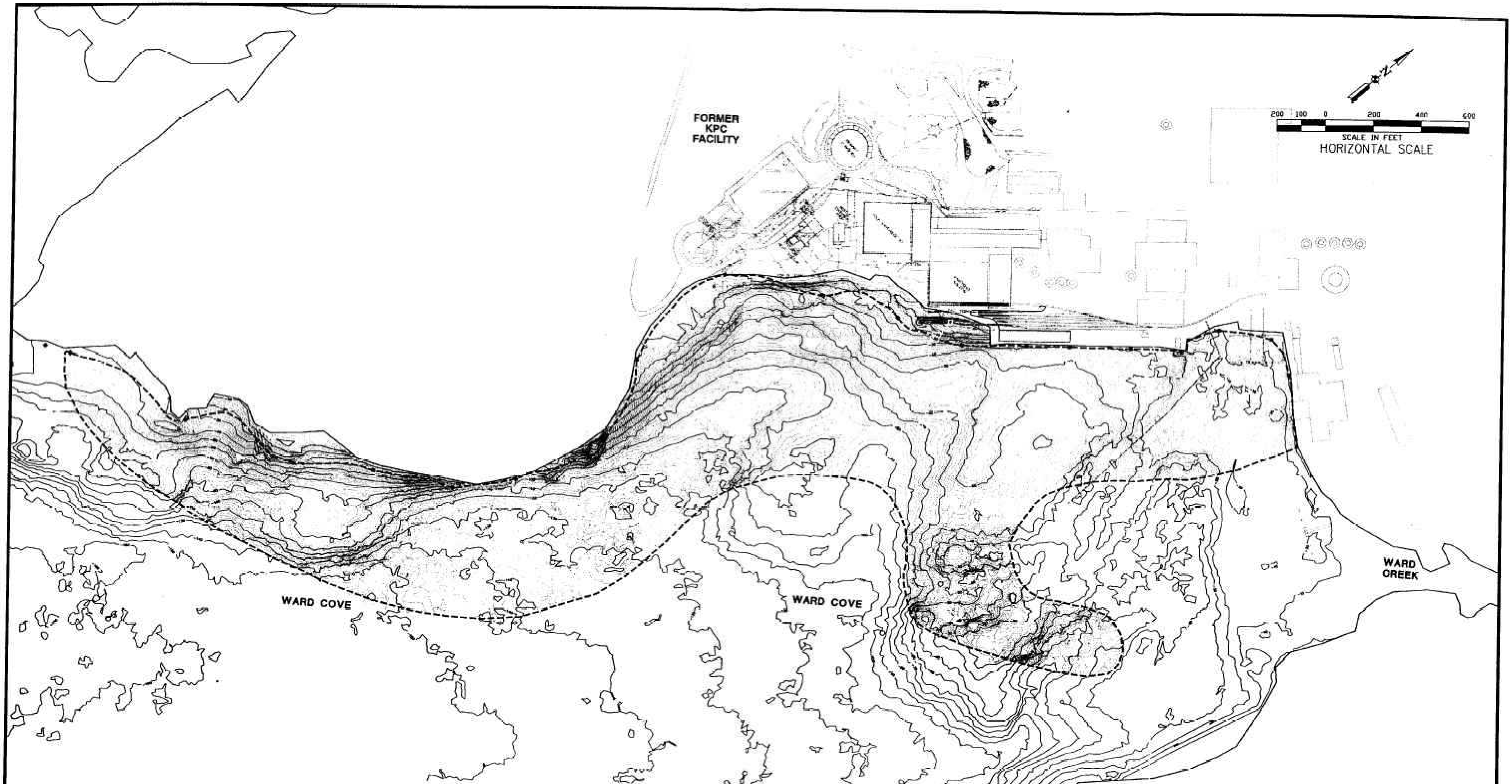


LEGEND

AREA OF CONCERN (AOC) (80 ACRES)

AOC SHOWN IN FEASIBILITY STUDY (87 ACRES)

Figure 15. Revisions in the nearshore boundary of the area of concern



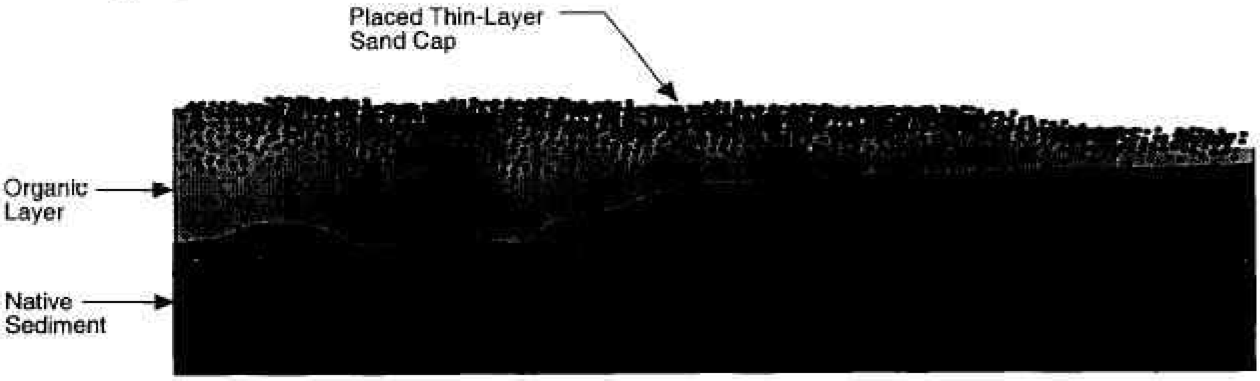
LEGEND

AREA OF CONCERN (AOC) (80 ACRES)

SHORELINE

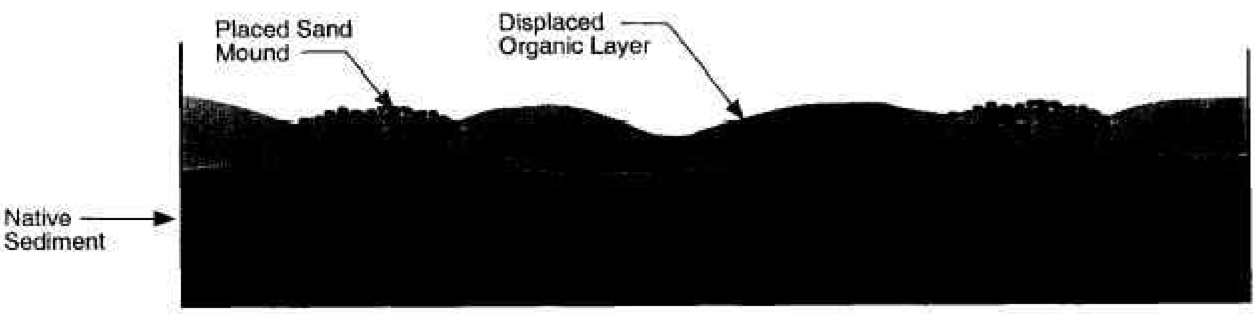
Figure 16. Area of concern

Thin Capping



- Application of capping material on soft organic layer
- Variable coverage: capping and surface sediment amendment

Mounding



- Placement of clean sandy material in mounds on soft organic layer with bearing capacity too limited to support a thin-layer cap
- Bottom of mound supported by native sediment or bedrock

Figure 17. Characteristics of thin capping vs. mounding

8600BOW.001 2302 03/20/00 WA

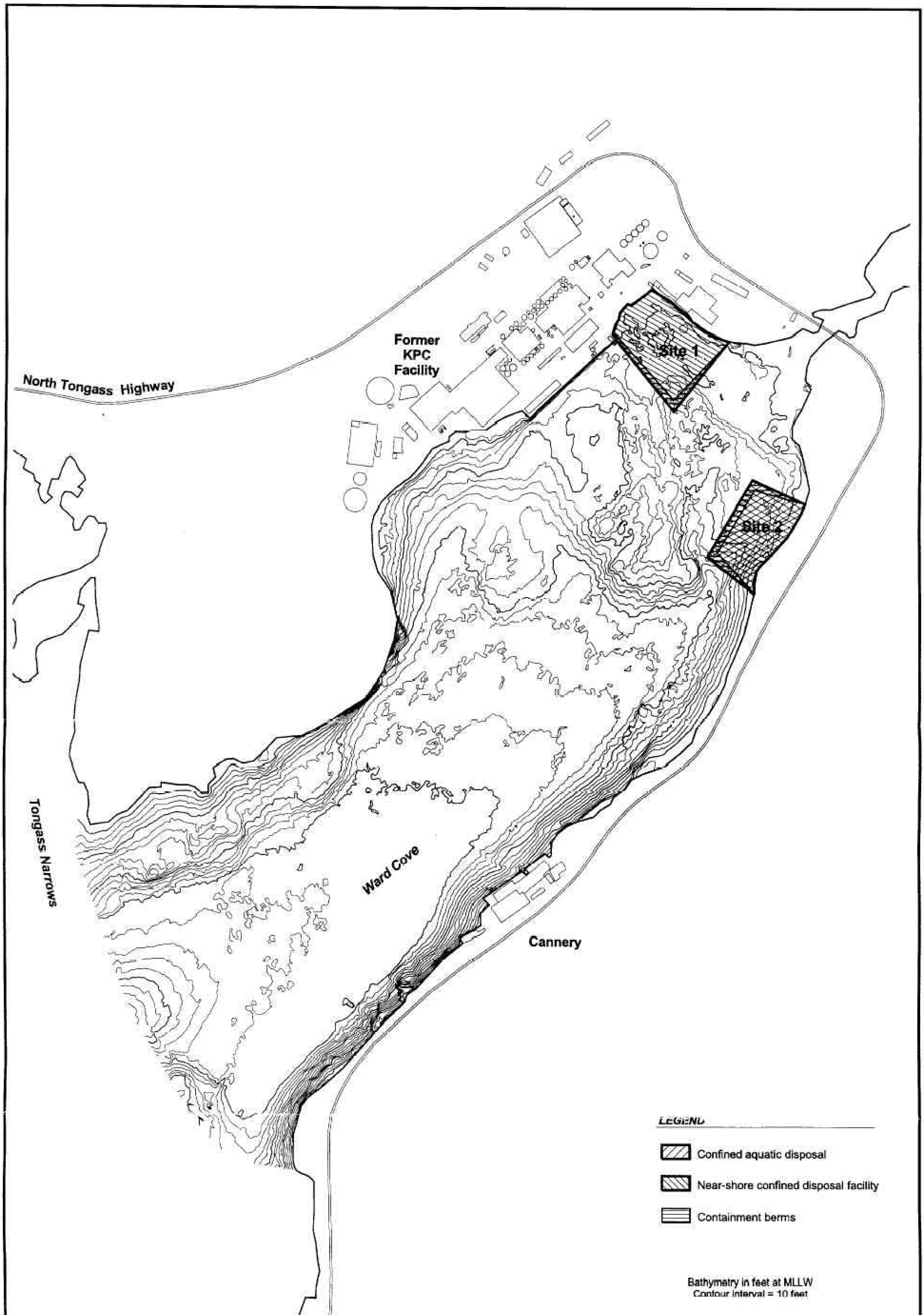


Figure 18. Preliminary disposal site locations.

8600B0W.001 2302 | Mar 22,2000 | View for Figure 10-7b | Layout for Figure 10-7 | g:\kpc\encrod0300.apr

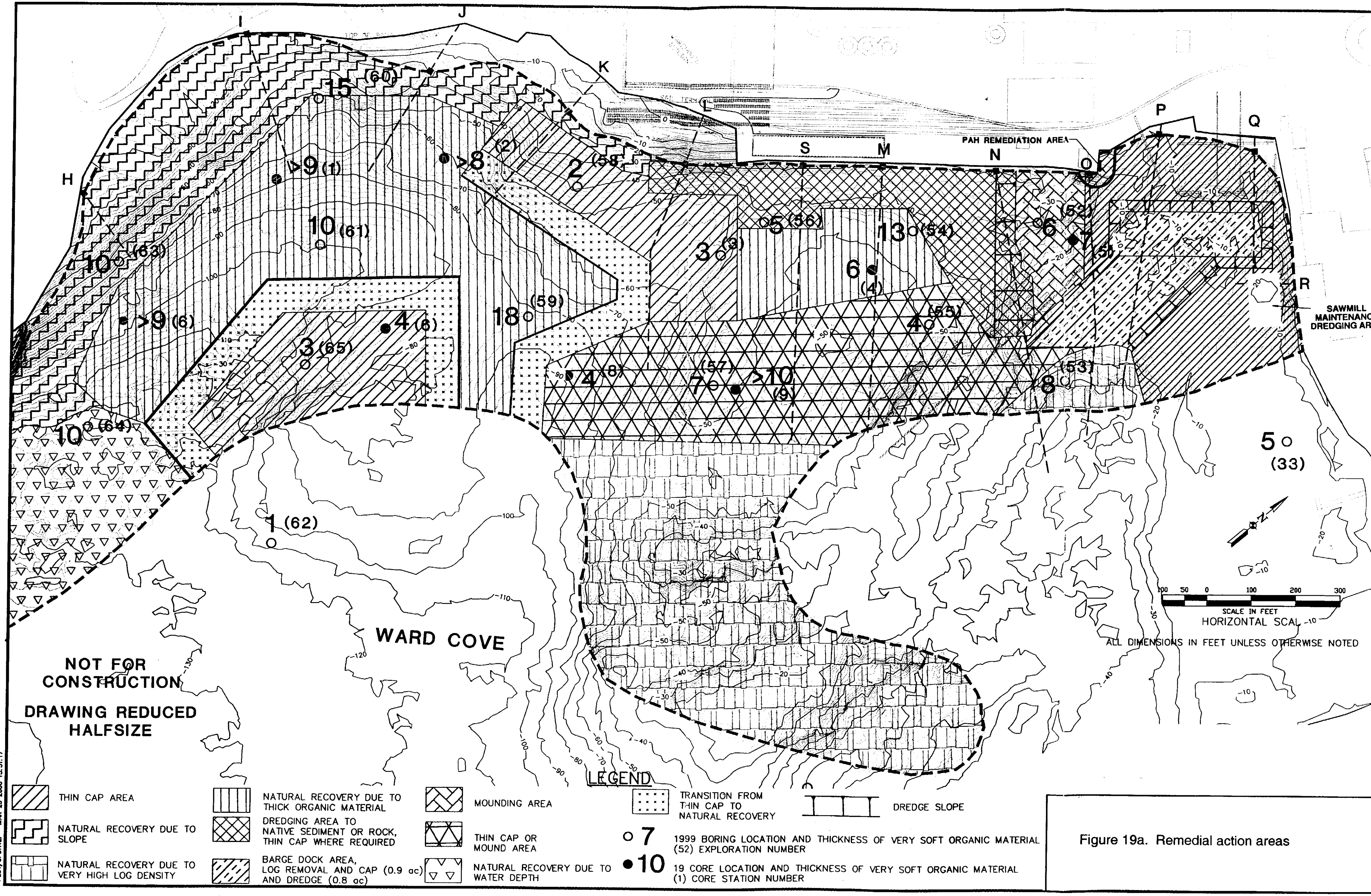


Figure 19a. Remedial action areas

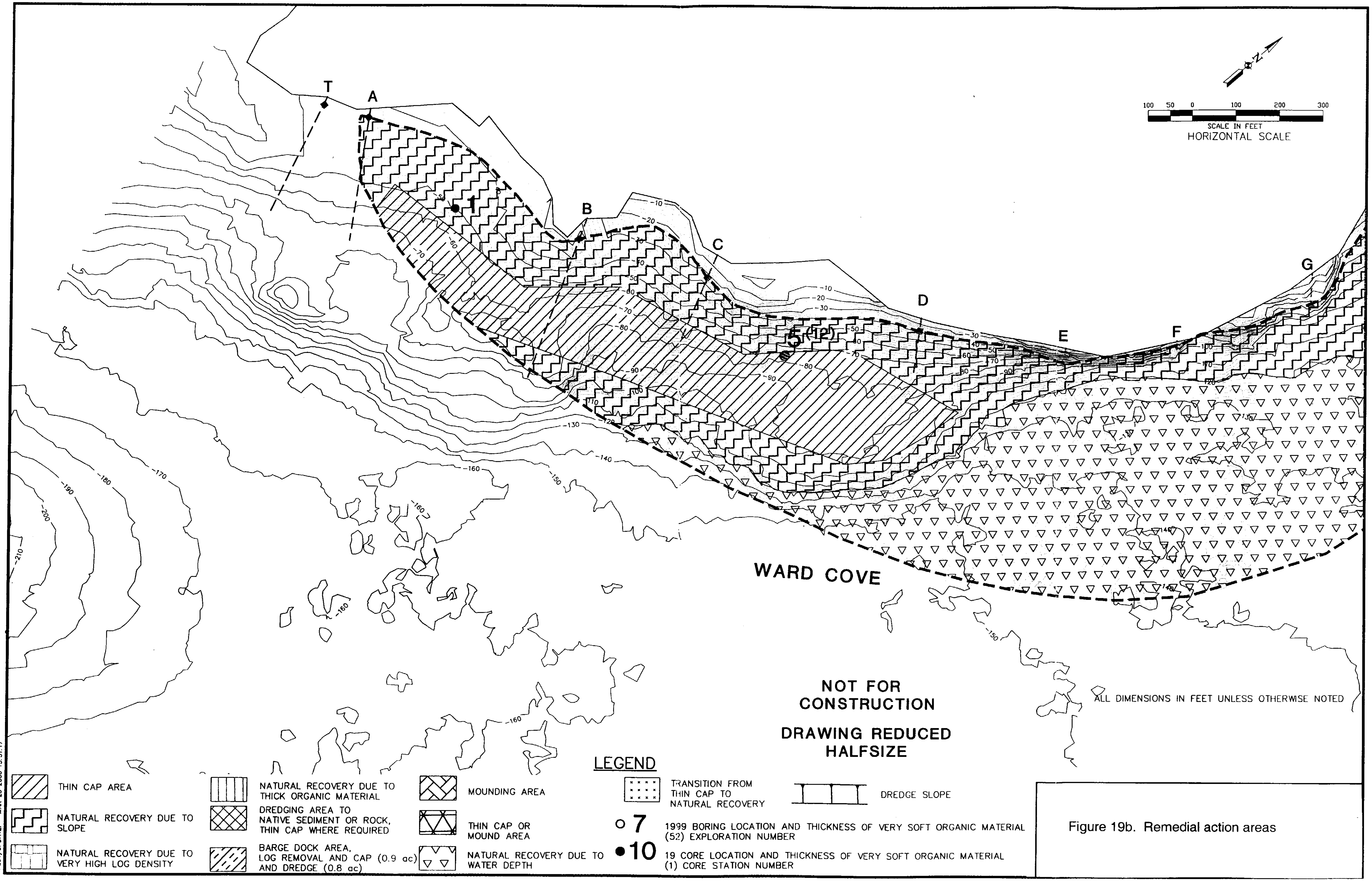


Figure 19b. Remedial action areas